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UNCLASSIFIED

ARMY MARKSMANSHIP AND GUNNERY TRAINING
I. Training Requirements for Individual Weapons

Human Engineering Report SpecDevCen-494-01-1

Under Contract #Nonr-494(01)
With Trustees of Tufts College
Medford 55, Mass.

Report Prepared by:
Richard S. Hirsch, Ph.D.
Project Director
Ezra V. Saul, Ph.D.
Research Associate

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SPECIAL DEVICES CEN
PORT WASHINGTON, L.I., N.Y.

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19 June 1952

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SECURITY INFORMATION

HUMAN ENGINEERING DIVISION
SPECIAL DEVICES CENTER
PORT WASHINGTON, NEW YORK

INTRODUCTION: This is one of a series of the Special Devices Center's Technical Reports on Army training in marksmanship and gunnery. The present report concerns itself with individual weapons. In order to provide an equitable distribution of the work load among the field teams, "individual weapons" have been taken (somewhat arbitrarily) to include small arms, submachine guns, machine guns, rocket and grenade launchers, recoilless rifles, and mortars. Other technical reports in this series deal with training in Artillery and Armor, Antiaircraft Artillery, and Guided Missiles.

PURPOSE: This is a survey to determine where modifications in instructional techniques and the development of training aids can improve training effectiveness and permit the more economical and efficient use of training ammunition. A second phase of this work is already underway to seek means of implementing the findings.

RESULTS: Based on the observation of marksmanship training in the field and in the classroom at The Infantry School, four infantry training divisions, an armored training division, an airborne infantry training division, and a Marine Recruit Depot, the survey team found that where demonstration is used as part of the training session, Army marksmanship training is in accord with good training principles. Practical work sessions also merit promise. The use of the "county fair" method was found to be effective and to make the best use of instructor personnel.

Principal barriers to good training include dependence upon lecture and extremely large classes. The physical environment is often not conducive to good learning; e.g. sometimes public address equipment is missing or there are distractions in the immediate neighborhood. Too often, work and fatigue details take precedence over scheduled training. Good training aids, especially training films, are lacking and, where available, are not fully utilized. The attempt to motivate the trainees is often limited to punishment. All of these shortcomings are aggravated by a shortage of qualified instructors and supervisory personnel.

RECOMMENDATIONS:

A. Some of these problems are open to immediate attack:

1. Improve the physical environment in such respects as ventilation, etc.
2. Attention to reducing the turnover among instructor personnel.
3. Provide better training, supervision, and assistants for the staff of instructors.
4. Wider use of the "county fair" method of training.

5. Make provision in schedules for necessary work and fatigue details, so that they do not occur when a man is scheduled for training.

B. A longer range program should investigate and specify the training aid requirements in support of individual weapons marksmanship training.

1. Special attention to training films, television, and kinescope recordings is recommended.
2. Research aimed at the modification of instructional methods and their integration with training aids -whether existing,under development or required.

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SECTION I

INTRODUCTION

The Problem

The purpose of this project was to survey the present status of Army training aids, devices, and instructional procedures used to teach gunnery and marksmanship in individual weapons. The specific objective of the survey, as stated by the Task Order, was "to determine by appropriate educational techniques where training can be improved and expenditures of training ammunition curtailed." The following definitions served as guides in the conduct of the research:

1. "Gunnery and marksmanship" for the purposes of this survey are taken to include the skills whereby a gun, howitzer, mortar, arm, weapon, missile or launcher is charged or loaded, and laid or directed, and the trajectory and strike directed and observed; including all skills and procedures incidental and concurrent thereto; but excluding the more remote skills such as care and maintenance of the piece, ammunition and range equipment; assembly and disassembly of the piece and ammunition; and excluding the knowledge of nomenclature, functioning, tactical employment and markings.*

2. "Training aids" was here used as a general term to include training accessories (manuals, charts), mechanical devices, and procedures.

The Weapons

It was intended that the following weapons would be either included in or, as noted, specifically excluded from the study:

Small Arms:
- Rifle, caliber .30, M1
- Rifle, caliber .30, M1C
- Carbine, caliber .30, M1
- Carbine, caliber .30, M2
- Browning Automatic Rifle, caliber .30, M1918A2
- Pistol, Automatic, caliber .45, M1911A1
- Submachine Gun, caliber .45, M3
- Submachine Gun, caliber .45, M3A1

*From the minutes of the Steering Committee meeting at Fort Knox on 19 September 1951.

Rockets:	2.36-inch Rocket Launcher, M18 3.5-inch Rocket Launcher, M20 Grenade Launcher, M7 Grenade Launcher, M7A1 Grenade Launcher, M7A2 Flame Thrower, Portable, M2A1 Sniperscope, Infrared, Set No. 1, 20,000 volts
Machine Guns:	Browning Machine Gun, caliber .30, M1919A6 Browning Machine Gun, caliber .30, M1917A1 Browning Machine Gun, caliber .50 HB, M2 (Ground use only)
Recoilless Rifles:	57-mm Rifle, M18 75-mm Rifle, M20 105-mm Rifle, M27
Mortars	60-mm Mortar, M2 81-mm Mortar, M1 4.2-inch Chemical Mortar, M2

Weapons specifically excluded from the survey:

Thompson Submachine Gun, caliber .45, M1928A1
37-mm Gun, Antitank, M3
57-mm Gun, M1

Some of the weapons which were originally included in the survey were not subsequently investigated because they had been declared obsolete or were in short supply. These included the 2.36-inch Rocket Launcher, the Sniperscope, and the 105-mm Recoilless Rifle. In addition, because of the nature of the "marksmanship" involved, training on the portable flame thrower was also not observed.

Sources of Information

1. Field activities

Training was observed at a total of seven Army installations and one Marine Corps base as follows:

The Infantry School, Fort Benning, Georgia
Sixth Infantry (Training) Division, Fort Ord, California
Seventh Armored (Training) Division, Camp Roberts, California
Eighth Infantry (Training) Division, Fort Jackson, South Carolina
Ninth Infantry (Training) Division, Fort Dix, New Jersey
Tenth Infantry (Training) Division, Fort Riley, Kansas

101st Airborne Infantry (Training) Division, Camp Breckinridge, Kentucky
Marine Recruit Depot, Parris Island, South Carolina

The length of the visits varied from five weeks (two observers) at The Infantry School, Fort Benning, to one week (one observer) at Camp Breckinridge. The observations involved approximately 1120 hours of training. In addition, interviews were held with training authorities in charge of instruction of a number of National Guard and Army ROTC units.

In general, the observations of training at the seven Army installations provided the most valuable material for the purposes of this survey; accordingly, this report deals mainly with training as observed at the installations listed above.

2. Literature survey

Introduction. In addition to the observations, a systematic survey of a limited portion of the literature related to the problem of marksmanship was undertaken. The literature is not extensive, although some limited research and experimental studies were conducted prior to World War II. Most of these are basic in nature and are concerned with specific aspects of the problem, such as motor steadiness and vision. A bibliography will be found at the end of the report.

Considerable research indicates the importance of visual and motor factors in marksmanship performance. On the other hand, experimental evidence was not found concerning the effectiveness of specific training procedures and devices in marksmanship instruction.

Visual factors. The bulk of the research on visual factors in marksmanship performance deals with the role of ocular dominance in marksmanship. Studies by Bannister (2), Lebensohn (17), and Simpson and Sommer (26) produced divergent results on the relationship of ocular dominance to scores in rifle firing. Bannister and Lebensohn found that right-eyed shooters generally obtain better scores than left-eyed shooters (both groups firing from the right shoulder). Simpson and Sommer, however, obtained results indicating that marksmanship scores are not related to eye dominance. Crider (4) in 1943 critically summarized these and other contradictory results, and his conclusion was that further research was required (a) to develop accurate and reliable measures of eye dominance and (b) to investigate the relationship of these measures to marksmanship and other related visual performances.

In addition to the experimental studies, there are a number of non-research publications which deal with specific aspects of marksmanship training. For example, articles by Weston (35) and

Reeves (22) point out that it is difficult to achieve simultaneous visual resolution (i.e., focus) of both the target and the weapon's sights. These experts, therefore, advocate training which permits the target to become blurred while the sights are held in clear focus. The U. S. Army, on the other hand, has adopted a policy which attempts to teach the trainee to maintain simultaneous visual clarity of both target and sights. Experimental evidence is not available in support of either practice. Accordingly, research is indicated to determine the importance of visual factors in marksmanship; furthermore, research is needed to resolve the divergent opinions and experimental results dealing with vision and marksmanship performance.

Motor factors. A number of studies have been reported concerning motor factors in marksmanship performance, such as muscular steadiness. For example, investigations by Spaeth and Dunham (27), Seashore and Adams (25), and Humphreys, Buxton and Taylor (16) all agree that tests of motor steadiness are highly correlated with rifle marksmanship scores. Moreover, they conclude that "good" and "poor" rifle shooters are well discriminated by test batteries of motor steadiness and that steadiness increases with practice. The consistency of these findings strongly suggests the possibility of the application of motor steadiness measures for either selection of personnel and/or the evaluation of training.

Edwards (13) investigated the amount of finger tremor in the presence of sounds of gunfire. He found that finger tremor was greater in subjects who had had combat experience than in those without such experience. Davis and Van Liere (5) found indications that large muscular responses resist adaptation to continued exposure to gunfire. These conclusions suggest that repeated and continued exposure to gunfire reduces motor steadiness. Motor steadiness, on the other hand, is a requirement for proficiency in marksmanship. The implications of these findings indicate that further extensive research is required to determine the role of motor factors in marksmanship performance.

Training procedures. A considerable body of literature has been written dealing with training methods, procedures, and instructional aids. However, there are little or no data available from which objective judgments can be made concerning the extent of their effectiveness.

In short, little of the experimental studies and findings have been applied and validated in a practical training situation; on the other hand, few of the practices, devices, and methods employed in the current training programs have been subjected to experimental analysis.

Methodology Employed to Collect Data

The bulk of material included in this report was obtained by observation of training. No special procedures were employed to unearth the problems; rather, considerable time was spent by observers in the field, on the firing ranges, at the training areas, and in the classrooms.

An informal check list was used to remind the observers to watch for practices, applied learning principles, ammunition expenditures, size of classes, weather conditions, and student (and instructor) characteristics.

Wherever possible, particularly during the early stages of the survey, the entire period devoted to a lesson comprised a single observation. Thus an eight-hour lesson on "positions" in rifle marksmanship constitutes one observation, and, as indicated, the observers did at first spend a full day on such lessons. Later, as time became more pressing and the observers became more familiar with the problem, the time spent on a lesson was cut to as little as an hour. However, in only rare instances was less than an hour utilized for a single observation.

SECTION II

SURVEY FINDINGS

This section deals with a summary of the observations of training on the various weapons studied. Eleven tables have been prepared to summarize this material. Since these tables all deal with the same problem, they are grouped together under a common number as Table 1. In order to distinguish one weapon from another, however, each of the tables has been lettered "A," "B," "C," etc. The eleven tables are as follows:

Table	
1 (A)	M1 Rifle
1 (B)	Carbine, M1 and M2
1 (C)	Pistol, .45 caliber, automatic
1 (D)	Automatic Rifle
1 (E)	Submachine Gun
1 (F)	Machine Guns
1 (G)	Grenade Launcher
1 (H)	Rocket Launcher
1 (I)	Recoilless Rifles
1 (J)	60-mm Mortar
1 (K)	81-mm and 4.2-inch Mortars

TABLE 1(A)
THE M-1 RIFLE

INSTRUCTIONAL TOPIC (1)	TRAINING AIDS: Actually Employed (2a)	TRAINING AIDS: Needed (2b)	APPRAISAL OF THE MOTIVATION (EXTRINSIC) EMPLOYED (3)	FACTORS OF LEARNING (4)	INSTRUCTOR-
Sighting and aiming (Not including sight corrections)	1. Sight picture device (group and individual sizes) 2. Page device 3. Sighting bar 4. Belgian aiming device 5. Triangulation equipment 6. Graphic training aids	1. Audio-visual aid to show effect of good and bad sighting 2. Device to check reliably and accurately individual's ability to get correct sight picture	Motivation employed: 1. Punitive discipline emphasized; praise rarely employed; marked absence of positive incentives. 2. Some indication that negative motivation results from lack of inclement weather schedules, weapon malfunctions, poorly prepared instructors, and certain methods of instruction. 3. No positive incentives provided and only rarely is competition used. 4. Scores are occasionally posted and the "highest" company is praised; however, individually only the "bolos" are affected. Thus, the emphasis is largely negative. Appraisal: Generally inadequate, inconsistent and haphazard. (For further discussion of this topic see pages 11-13 of the accompanying text.)	Practice: Very massed. Some evidence that one phase of instruction may interfere with others because the two are taught without a break. Large blocks of time given over to single units of training result in boredom, monotony, and psychological fatigue for both instructors and trainees. All range firing is concentrated into 3 (to 3½) consecutive days after 16 days of dry practice. Participation: Yes, but the amount varies as a function of time available. Amount of adequately supervised participation is not enough to master the tasks. In range firing, participation per student is only a small fraction of the time allotted per company. Knowledge of Results: Fair during triangulation exercises; poor to absent in all other phases. In firing positions exercises, there is none, or at best limited by the ability (and interest) of the student "coach." In range firing, fair to poor. Highly unreliable and delayed. (For further discussion of this topic see pages 14-18 of the accompanying text.)	Class Size: Sm... observed consist... present at probl... assigned; larges... present for trai... assigned. No. of Instructo... usually in the c... the class the fe... Appraisal: Gene... even with highly ... tors. The effec... ing with the pres... on the adequacy of methods of train... and equipment avai... bleachers, weapo... (For further dis... topic see pages ... accompanying tex...
Firing positions exercises	None	Device to provide knowledge of results during dry firing			
Trigger squeeze and breath control	1. Trigger squeeze device - group size (See Ft. Dix Training Aids Catalog) 2. Maj. Lea's device developed at Ft. Ord* 3. Fly rod attachment at Ft. Dix**	1. Device to give visual and kinesthetic (i.e., muscle sense) information and training 2. Dry firing device which gives knowledge of results			
Sustained and rapid fire (Dry firing)	None	Dry firing knowledge of results device			
Sight adjustment and scorebook	Graphic training aids	1. Group size model of rear sight to show corrections 2. Audio-visual aid (with participation) 3. Three-dimensional aid to teach principles of sight correction			
Range firing (Ammunition expended ranges from approximately 150 to 300 rounds per trainee)	None	Device to give automatic, immediate, and reliable knowledge of results and scores			

*This device consists of choke wire attachment to trigger housing group and it permits an instructor to fire the rifle by "remote control" while the student aims the rifle.
**Consists of attaching a fly-rod to demonstrator's back to illustrate the effect of breathing on steadiness.

TABLE 1(B)
THE CARBINE

INSTRUCTIONAL TOPIC (1)	TRAINING AIDS: Actually Employed (2a)	TRAINING AIDS: Needed (2b)	APPRAISAL OF THE MOTIVATION (EXTRINSIC) EMPLOYED (3)	FACTORS OF LEARNING (4)	INSTRUCTOR-TR... (
Preliminary Marksmanship (Not observed)			Marked absence of positive incentives.	Practice: Massed.	Generally inadequa... highly qualified i... highly motivated tr...
Range Firing (a) 500" and/or transition (Incomplete data indicates that - at one post - 28 rounds of ammunition expended per trainee)	None	1. Automatic scorer with immediate knowledge of results.	(For further discussion of this topic see Table 1(A) and pages 11-13 of the accompanying text.)	Participation: Varies according to number of available weapons. Knowledge of Results: Fair to poor. (For further discussion of this topic see Table 1(A) and pages 14-18 of the accompanying text.)	(For further disc... topic see Table 1... 19-20 of the accomp...

TABLE 1(C)
THE .45-CALIBER PISTOL

INSTRUCTIONAL TOPIC (1)	TRAINING AIDS: Actually Employed (2a)	TRAINING AIDS: Needed (2b)	APPRAISAL OF THE MOTIVATION (EXTRINSIC) EMPLOYED (3)	FACTORS OF LEARNING (4)	INSTRUCTOR-TR... (
Preliminary Marksmanship (a) Sighting and aiming (b) Firing positions (c) Trigger squeeze (d) Slow and sustained fire	1. Sighting bar and triangulation equipment.	1. Device with knowledge of results for dry fire.	Marked absence of positive incentives.	Practice: All the instruction and practice is concentrated into, at most, six consecutive hours. Participation:	Class Size: 185 ou... No. of Instructors Appraisal: Genera... even with highly q... tors.
Range Firing (Ammunition expended ranges from 25-30 rounds per trainee)	None		(For further discussion of this topic see Table 1(A) and pages 11-13 of the accompanying text.)	Knowledge of Results: Fair to poor. (For further discussion of this topic see Table 1(A) and pages 14-18 of the accompanying text.)	(For further discus... topic see Table 1( ) ... 19-20 of the accompan...

A

...NING	INSTRUCTOR-TRAINEE RATIO (5)	OBVIOUS DIFFERENCES BETWEEN TRAINING AND OPERATIONAL SITUATIONS (6)	COMMENTS (7)	PHASE II AND IMPLEMENTATION RECOMMENDATIONS (8)
...vidence that ...tion may ... because the ...t a break. ... given over ...raining notony, and ... for both ...eas. ... concentrated ...utive days ... practice. ... series as a ...liable. ... supervised ...nough to ...cipation ...small frac- ...ted per ...ion exer- ...in all ...ercises, ...st limited ...terest) of ...to poor. ...delayed. ...of this ...f the	Class Size: Smallest class observed consisted of 133 men present at problem out of 165 assigned; largest class was 246 present for training out of 321 assigned. No. of Instructors: 1 to 9 (and usually in the order of the larger the class the fewer instructors). Appraisal: Generally inadequate even with highly qualifed instructors. The effectiveness of training with the present ratio depends on the adequacy of the instructor, methods of training, facilities and equipment available (PA, bleachers, weapons, etc.). (For further discussion of this topic see pages 19-20 of the accompanying text.)	1. Targets employed may be artificial and may lead to undesirable attitudes toward firing at undefined targets. 2. Heavy emphasis on body orientation and positions may have little transfer value from range positions to combat positions. 3. Windage corrections do not appear to be realistically handled; reliance on the range flag for wind velocity estimation may have no combat carry-over. 4. "Battle sight" is used for most firing other than known distance firing on the range. 5. Concurrent training is not always related either to the immediate lesson or to long range marksmanship instruction (viz. physical training and close-order drill). (For further discussion of this topic see page 21 of the accompanying text.)	1. The need for some inclement weather schedules is ignored or rationalized as "good for the men." 2. Proficiency measures open to considerable question. 3. Hours of instruction specified by the official Army Training Program are in terms of time spent in the activity per company; the trainee gets only a fraction of the time indicated in the ATP.	Training procedures: 1. Job analysis of M-1 marksmanship performance. 2. Development of measures of proficiency of M-1 marksmanship. 3. Development of inclement weather schedules for marksmanship training and research on the effect of such schedules on qualification scores. 4. Determination of optimum class size (trainee-instructor ratio) for effective instruction. 5. Determination of the optimum length of blocks of instruction and the most advantageous distribution of practice. 6. Research on the effect of emphasis on body firing positions on proficiency in operational situation. 7. Determination of effect of clearly defined targets in known distance and 1000" firing on attitudes toward firing at poorly defined targets. Training aids: Development and validation of: 1. Knowledge of results device for all dry and wet firing practice. 2. Automatic and reliable scoring device for all phases of wet firing. 3. Individual trigger squeeze device which gives kinesthetic and visual knowledge of results. 4. Working model of M-1 rear sight (group size) for instruction on sight changes. 5. Device to teach principles of sight changes. 6. Instruments to measure an individual's sight picture and sighting behavior. 7. Training films to show correct sight pictures. Implementation suggestions: 1. Examine program of instruction for the inclusion of positive motivational incentives. 2. Determine relevancy of concurrent training.

...NG	INSTRUCTOR-TRAINEE RATIO (5)	OBVIOUS DIFFERENCES BETWEEN TRAINING AND OPERATIONAL SITUATIONS (6)	COMMENTS (7)	PHASE II AND IMPLEMENTATION RECOMMENDATIONS (8)
...er of ... of this ...i pages ...ng text.)	Generally inadequate even with highly qualified instructors and highly motivated trainees. (For further discussion of this topic see Table 1(A) and pages 19-20 of the accompanying text.)	(For further discussion of this topic see Table 1(A) and page 21 of the accompanying text.)	1. Amount of practice not adequate for mastery. 2. Apparent inaccuracy of the rear sight may develop unfavorable attitudes toward the carbine.	Training procedures: 1. Determine optimum length of blocks of instruction and most advantageous distribution of practice. 2. Determine optimum trainee-instructor ratio for most effective learning. 3. Job analysis and development of proficiency measures. 4. Research to determine whether carbine can be taught before M-1 as a less complicated weapon. Training aids: 1. Dry firing device with knowledge of results. 2. Automatic scoring device. Implementation suggestions: 1. Examine instruction for possible inclusion of positive motivational incentives.

...NG	INSTRUCTOR-TRAINEE RATIO (5)	OBVIOUS DIFFERENCES BETWEEN TRAINING AND OPERATIONAL SITUATIONS (6)	COMMENTS (7)	PHASE II AND IMPLEMENTATION RECOMMENDATIONS (8)
...practice ... most, ...n of this ... nd pages ...ng text.)	Class Size: 185 out of 250 No. of Instructors: 4 to 8 Appraisal: Generally inadequate even with highly qualified instructors. (For further discussion of this topic see Table 1(A) and pages 19-20 of the accompanying text.)	1. Range firing position appears to be an unrealistic one for combat. (For further discussion of this topic see Table 1(A) and page 21 of the accompanying text.)		Training procedures: 1. Determine the effect of small bore firing on .45 caliber. 2. Re-evaluate the training for realism in position exercises. 3. Job analysis and development of proficiency measures. Training aids: 1. Knowledge of results device for dry firing. Implementation suggestions: 1. Inclusion of positive motivational incentives in the instruction.

TABLE 1(D)
THE BROWNING AUTOMATIC RIFLE

INSTRUCTIONAL TOPIC (1)	TRAINING AIDS		APPRAISAL OF THE MOTIVATION (EXTRINSIC) EMPLOYED (3)	FACTORS OF LEARNING (4)	INSTRUCT
	Actually Employed (2a)	Needed (2b)			
Preliminary Marksmanship (a) Sighting and aiming (b) Firing positions (c) Trigger "press" (d) Breathing (e) Slow and sustained (dry) firing (f) Sight correction and scorebook	1. Sighting bar 2. Triangulation equipment	1. Knowledge of results device for dry firing. 2. Device (individual) to teach trigger "press."	Marked absence of positive incentives. (For further discussion of this topic see Table 1(A) and pages 11-13 of the accompanying text.)	Practice: Exceedingly massed. (At some po the instruction is condensed into a period ranging from 4 to 8 consecutive hours.) Participation: Amount varies as a function of time and weapons available. In range firing, participation per student is only a small fraction of time allotted to company. Knowledge of Results: Poor to absent in all phases prior to range firing. In range firing knowledge of results seems fair but generally delayed. (For further discussion of this topic see Table 1(A) and pages 14-18 of the accompanying text.)	Class Size: observed consi present at pr assigned; lar present for tr assigned. No. of Instruc reverse order Appraisal: Ge even with high tors. The eff ing with the pr on the adequac methods of tra and equipment bleachers, wea (For further topic see Tab 19-20 of the
Range Firing (a) 500" (b) Known distance (c) Transition (Ammunition expenditure ranges from 36 to 60 rounds per man - data incomplete)	None	1. Automatic scorer with immediate knowledge of results. 2. Film for technique of fire.			

TABLE 1(E)
THE SUB MACHINE GUN

INSTRUCTIONAL TOPIC (1)	TRAINING AIDS		APPRAISAL OF THE MOTIVATION (EXTRINSIC) EMPLOYED (3)	FACTORS OF LEARNING (4)	INSTRUCTOR
	Actually Employed (2a)	Needed (2b)			
Preliminary Marksmanship (a) Sighting and aiming (b) Positions	None		Marked absence of positive incentives. (For further discussion of this topic see Table 1(A) and pages 11-13 of the accompanying text.)	Practice: Massed and insufficient. Time allotted problem varies from 1 to 4 hours. At one post all instruction, including firing, given in one hour. Participation: Poor to fair. One post had only one hour for firing; hence, only a few trainees selected to "demonstrate." Knowledge of Results: Fair to poor. (For further discussion of this topic see Table 1(A) and pages 14-18 of the accompanying text.)	Generally inade (For further topic see Tab 19-20 of the
Range Firing		1. Knowledge of results scorer.			

TABLE 1(F)
THE MACHINE GUNS

INSTRUCTIONAL TOPIC (1)	TRAINING AIDS		APPRAISAL OF THE MOTIVATION (EXTRINSIC) EMPLOYED (3)	FACTORS OF LEARNING (4)	INSTRUCT
	Actually Employed (2a)	Needed (2b)			
Crew Drill	None	1. Audio-visual aid	Motivation employed: 1. Some exceptional instances of inter-squad (or other group size) competition. 2. Some scoring and target critiques. However, no positive incentives provided. Appraisal: Generally a lack of adequate motivation beyond what intrinsic desire to learn exists in the trainee. (For further discussion of this topic see Table 1(A) and pages 11-13 of the accompanying text.)	Practice: Massed. Training on the .50 caliber is usually concentrated into one "familiarization" firing session. Participation: Limited as a function of weapon availability (at one post, only 17 at the problem). Knowledge of Results: Fair to poor. Target critiques delayed. Lack of tracer ammunition at one post made firing and knowledge of results almost meaningless. (For further discussion of this topic see Table 1(A) and pages 14-18 of the accompanying text.)	Class Size: observed con present at p assigned; la present for t assigned. No. of Instr Appraisal: Ge for proper c sion. (For further topic see Ta 19-20 of the
Measuring and Laying of Angles	1. Traversing dial model 2. Clinometer model 3. Rear sight model 4. OTA's	1. Audio-visual aid			
Manipulation Exercises (Sighting and aiming)	1. Triangulation materials 2. Rear sight model 3. Sight picture	1. Audio-visual aid 2. Dry firing device which provides some knowledge of results.			
Range Firing Ammunition expenditure ranged from 48 to 162 rounds per man (on 500-inch firing). On the .50 caliber the ammunition expenditure ranges from 10 to 36 rounds per man.	1. Paper landscape firing targets	1. Automatic scoring devices			

...NING	INSTRUCTOR-TRAINEE RATIO (5)	OBVIOUS DIFFERENCES BETWEEN TRAINING AND OPERATIONAL SITUATIONS (6)	COMMENTS (7)	PHASE II AND IMPLEMENTATION RECOMMENDATIONS (8)
...At some posts ...densed into ...4 to 8 con- ...ction of ...able. In ...ation per ...l fraction ...mpany. ...phases prior ...ange firing ...ems fair ...n of this ...nd pages ...ing text.)	Class Size: Smallest class observed consisted of 154 men present at problem out of 174 assigned; largest class was 215 present for training out of 243 assigned. No. of Instructors: 3 to 8 (in reverse order to class size). Appraisal: Generally inadequate even with highly qualified instructors. The effectiveness of training with the present ratio depends on the adequacy of the instructor, methods of training, facilities and equipment available (PA, bleachers, weapons, etc.). (For further discussion of this topic see Table 1(A) and pages 19-20 of the accompanying text.)	Heavy emphasis on body firing positions may have questionable transfer value from range firing to combat firing. (For further discussion of this topic see Table 1(A) and page 21 of the accompanying text.)	1. Weapons seen as persistently malfunctional. This may have serious effect on "confidence" in weapon. 2. Perhaps some learning interference resulting from conflicting rules for sight corrections on the M-1 and the Automatic Rifle.	Training procedures: 1. Determine optimum length of blocks of instruction and most advantageous distribution of practice. 2. Determine optimum trainee-instructor ratio for most effective learning. 3. Job analysis and development of proficiency measures. Training aids: 1. Dry firing devices with knowledge of results. 2. Scoring device with immediate knowledge of results. 3. Trigger "press" device. Implementation suggestions: 1. Examine program of instruction for the inclusion of positive motivational incentives. 2. Determine relevancy of concurrent training.

...ING	INSTRUCTOR-TRAINEE RATIO (5)	OBVIOUS DIFFERENCES BETWEEN TRAINING AND OPERATIONAL SITUATIONS (6)	COMMENTS (7)	PHASE II AND IMPLEMENTATION RECOMMENDATIONS (8)
... Time ...from 1 to ...1 instruc- ...given in ... had only ...ce, only ...to "demon- ... of this ...d pages ...ng text.)	Generally inadequate. (For further discussion of this topic see Table 1(A) and pages 19-20 of the accompanying text.)	(For discussion of this topic see Table 1(A) and page 21 of the accompanying text.)		Training procedures: 1. Job analysis and development of proficiency measures. 2. Determination of optimum class size and most advantageous distribution of practice. Training aids: 1. Knowledge of results device and automatic scorer. Implementation suggestions: 1. Inclusion of positive motivational incentives.

...NING	INSTRUCTOR-TRAINEE RATIO (5)	OBVIOUS DIFFERENCES BETWEEN TRAINING AND OPERATIONAL SITUATIONS (6)	COMMENTS (7)	PHASE II AND IMPLEMENTATION RECOMMENDATIONS (8)
...ne .50 ...centrated ...ion" firing ...of weapon ...st, only ...critiques ...er ammuni- ...firing and ...almost mean- ...on of this ...and pages ...ying text.)	Class Size: Smallest class observed consisted of 137 men present at problem out of 185 assigned; largest class was 221 present for training out of 233 assigned. No. of Instructors: 1 to 9 Appraisal: Generally inadequate for proper control and supervision. (For further discussion of this topic see Table 1(A) and pages 19-20 of the accompanying text.)	1. "Search and traverse" targets give indication that there may be some confusion on the task to be mastered. 2. Dry firing on "search and traverse" targets appears to be unrealistic. (For further discussion of this topic see Table 1(A) and page 21 of the accompanying text.)	1. Landscape targets (paper) may have transfer value which should be investigated. 2. Certain important human engineering problems are present as a result of weapon design. For example: (a) Deflection and elevation control knobs function contrary to expectancy (not applicable to bipod mounted guns). (b) Operator responses are reversed from model to model (light and heavy). (c) Scales on the traversing disk and on clinometer are graduated in different units. 3. Overlapping of training on the light and heavy machine gun tends to interfere with the responses learned. 4. Training on the light machine gun is somewhat haphazard - trainees frequently do not receive preliminary instruction prior to firing.	Training procedures: 1. Determination of optimum class size (instructor-trainee ratio) for efficient learning. 2. Determination of optimum length of a block of instruction and most advantageous distribution of practice. 3. Determination of effect of delayed target critique on firing performance. 4. Determination of whether use of landscape targets will facilitate mastery of "search and traverse" task. 5. Job analysis and development of proficiency measures. Training aids: 1. Development and validation of knowledge of results device for use in dry firing. 2. Development and validation of device to give automatic, immediate, and reliable knowledge of results and scores in wet firing. 3. Production of training films. Implementation suggestions: 1. Inclusion of positive motivational incentives. 2. Re-scheduling of instruction to minimize (or eliminate) interfering responses required by conflicting mechanical characteristics on the light and heavy guns.

TABLE 1(G)
THE GRENADE LAUNCHER

INSTRUCTIONAL TOPIC (1)	TRAINING AIDS		APPRAISAL OF THE MOTIVATION (EXTRINSIC) EMPLOYED (3)	FACTORS OF LEARNING (4)	INSTRU
	Actually Employed (2a)	Needed (2b)			
Preliminary Marksmanship (a) F-15 sight (b) Sighting and aiming (c) Positions	1. OTA's	1. Orientation film	Marked absence of positive incentives. (For further discussion of this topic see Table 1(A) and pages 11-13 of the accompanying text.)	Practice: Extremely massed. All instruction on this topic usually given in single day. Also limited ammunition provides limited practice for mastery. Participation: Varies according to time and ammunition allowances. Knowledge of Results: Fair to poor. (For further discussion of this topic see Table 1(A) and pages 14-18 of the accompanying text.)	Generally ... of near-fat... possibly, ... vision. (For furth... topic see ... 19-20 of ...
Range Firing	1. Training (inert) shell	1. Same shell with smoke charge			

TABLE 1(H)
THE ROCKET LAUNCHER

INSTRUCTIONAL TOPIC (1)	TRAINING AIDS		APPRAISAL OF THE MOTIVATION (EXTRINSIC) EMPLOYED (3)	FACTORS OF LEARNING (4)	INSTRU
	Actually Employed (2a)	Needed (2b)			
Preliminary Marksmanship (a) Sighting and aiming (b) Firing positions (c) Trigger squeeze (d) Boresighting (e) Tracking	1. Tracking device 2. Triangulation equipment 3. Boresighting equipment	1. Device for dry firing with knowledge of results. 2. Realistic tracking trainer. 3. Three-dimensional aid to teach principles of boresighting. 4. Film (orientation)	Marked absence of positive incentives. (For further discussion of this topic see Table 1(A) and pages 11-13 of the accompanying text.)	Practice: Massed. Participation: Varies according to time and ammunition allowances. Knowledge of Results: 1. Large number of "duds" in ammunition tended to cut down effectiveness of training. (For further discussion of this topic see Table 1(A) and pages 14-18 of the accompanying text.)	Class Size: No. of Instru... Appraisal: ... even with hi... tors. (For furthe... topic see T... 19-20 of th...
Range Firing Ammunition expenditure ranged (as observed) from 1-3 rounds TP (and at one post only 1 round HEAT with no TP).	1. Moving targets				

TABLE 1(I)
THE RECOILLESS RIFLES

INSTRUCTIONAL TOPIC (1)	TRAINING AIDS		APPRAISAL OF THE MOTIVATION (EXTRINSIC) EMPLOYED (3)	FACTORS OF LEARNING (4)	INSTRUC
	Actually Employed (2a)	Needed (2b)			
Crew Drill	None	Orientation film	Marked absence of positive extrinsic incentives. (For further discussion of this topic see Table 1(A) and pages 11-13 of the accompanying text.)	Practice: Massed. Participation: Markedly limited due to weapon shortage and ammunition restrictions. Knowledge of Results: In range firing tracer ammunition somewhat helpful in subcaliber firing; however, no scoring is employed. (For further discussion of this topic see Table 1(A) and pages 14-18 of the accompanying text.)	Class Size: observed co... present at ... assigned; 1 present for assigned. No. of Instru... Appraisal: (For further ... topic see T... 19-20 of th...
Preliminary Marksmanship (a) Sight picture (b) Positions (c) Trigger squeeze (d) Tracking (e) Boresighting (f) Fire control instruments (g) Examination	1. Group and individual size sight picture devices 2. Tracking trainers	1. Device for dry firing with knowledge of results feature. 2. Tracking trainer which permits simultaneous elevation and deflection corrections. 3. Inert loading practice round. 4. Model of sight for effective instruction showing distance perspective.			
Range Firing (a) 1000 inch (b) KD (c) Transition	1. Moving target 2. Subcaliber firing devices	1. Moving target which varies both horizontally and vertically. 2. Subcaliber device to provide realistic backblast and noise.			

A

LEARNING	INSTRUCTOR-TRAINEE RATIO (5)	OBVIOUS DIFFERENCES BETWEEN TRAINING AND OPERATIONAL SITUATIONS (6)	COMMENTS (7)	PHASE II AND IMPLEMENTATION RECOMMENDATIONS (8)
All instruction ly given in limited ammuni- ted practice for time and ammu- s: ussion of this A) and pages panying text.)	Generally inadequate. Instance of near-fatal accident due, possibly, to inadequate supervision. (For further discussion of this topic see Table 1(A) and pages 19-20 of the accompanying text.)	(For discussion of this topic see Table 1(A) and page 21 of the accompanying text.)		Training procedures: 1. Job analysis and development of proficiency measures. 2. Determination of optimum class size and most advantageous distribution of practice. Training aids: 1. Development of training shell with smoke charge. Implementation suggestions: 1. Inclusion of positive motivational incentives.

ARNING	INSTRUCTOR-TRAINEE RATIO (5)	OBVIOUS DIFFERENCES BETWEEN TRAINING AND OPERATIONAL SITUATIONS (6)	COMMENTS (7)	PHASE II AND IMPLEMENTATION RECOMMENDATIONS (8)
time and ammu- "duds" in ammu- cut down training. ssion of this A) and pages anying text.)	Class Size: 180 to 220 No. of Instructors: 2 to 8 Appraisal: Generally inadequate even with highly qualified instructors. (For further discussion of this topic see Table 1(A) and pages 19-20 of the accompanying text.)	1. Tracking training appears to be unrealistic. 2. Amount of actual firing contributes almost nothing to the mastery of firing and marksmanship. (For further discussion of this topic see Table 1(A) and page 21 of the accompanying text.)	1. Some evidence that students have difficulty mastering the principle of "tree" type sight.	Training procedures: 1. Job analysis and development of proficiency measures. 2. Determination of optimum class size and most advantageous distribution of practice. Training aids: 1. Tracking trainer. 2. Dry firing device with knowledge of results. 3. Three-dimensional device to teach boresighting principles. 4. Device to teach principles of the tree-type sight. Implementation suggestions: 1. Inclusion of positive motivational incentives.

ARNING	INSTRUCTOR-TRAINEE RATIO (5)	OBVIOUS DIFFERENCES BETWEEN TRAINING AND OPERATIONAL SITUATIONS (6)	COMMENTS (7)	PHASE II AND IMPLEMENTATION RECOMMENDATIONS (8)
to weapon tion restric- er ammunition subcaliber scoring is sion of this A) and pages panying text.)	Class Size: Smallest class observed consisted of 156 men present at problem out of 185 assigned; largest class was 219 present for training out of 230 assigned. No. of Instructors: 4 to 7 Appraisal: Generally inadequate. (For further discussion of this topic see Table 1(A) and pages 19-20 of the accompanying text.)	1. Lack of realism in subcaliber firing. 2. Lack of realism in moving targets. (For further discussion of this topic see Table 1(A) and page 21 of the accompanying text.)	1. Weapon shortage limits training, sometimes to as little as four hours. 2. Firing pins and shoulder rests, when used as a ground rest in prone position, are easily broken.	Training procedures: 1. Job analysis of marksmanship performance. 2. Development of proficiency measures on various phases of marksmanship performance. 3. Determination of optimum length of blocks of instruction and optimum distribution of practice. 4. Determination of optimum class size which can be taught to a defined criterion of proficiency. Training aids: 1. Development and validation of a knowledge of results device for use in dry firing practice. 2. Development and validation of realistic tracking trainer which permits simultaneous elevation and deflection training. 3. Development and validation of realistic subcaliber firing device which provides noise and backblast comparable to service ammunition. 4. Modification and validation of existing sight picture device to provide distance perspective when targets vary in range. 5. Development and validation of various training films on various aspects of recoilless rifle marksmanship. Implementation suggestions: 1. Inclusion of positive motivational incentives.

TABLE 1(J)
THE 60 mm. MORTAR

INSTRUCTIONAL TOPIC (1)	TRAINING AIDS		APPRAISAL OF THE MOTIVATION (EXTRINSIC) EMPLOYED (3)	FACTORS OF LEARNING (4)	INSTR
	Actually Employed (2a)	Needed (2b)			
Crew Drill	None	1. Film to demonstrate proper crew performance.	Motivation employed: 1. Some inter-squad competition. 2. Some self-competition in laying mortars against time. Appraisal: Since approximately 80 hours of company time is allocated to 60 mm. instruction, the lack of frequent and readily achieved positive goals is important. (For further discussion of this topic see Table 1(A) and pages 11-13 of the accompanying text.)	Practice: Excessively massed - as much as 8-9 hours of crew drill in one day. Participation: Yes, although amount depends on weapon and ammunition availability. Knowledge of Results: Fair to poor, depending on the instructor's ability and student coach's interest and ability. In range firing, fair to poor; inert training shell gives little or no knowledge of results; erratic rounds tend to throw students' judgments off. (For further discussion of this topic see Table 1(A) and pages 14-18 of the accompanying text.)	Class Size observed present a assigned; present fo assigned. No. of Ins usually reve size. Appraisal: to meet eve for adequate and supervis type of ins ularly a it require structor pa (For furt topic see 19-20 of
Gunner's Examination (Practice and test)	1. Cook Demonstrator	1. Modification of Cook Demonstrator to show shell trajectory. 2. Class size working mock-up of M-4 Sight.			
Technique of Fire, including: (a) Arithmetic components (b) Forward observation procedure (c) Fire commands (d) Fire adjustment	1. OTA 2. Terrain boards 3. Puff boards 4. Puff sticks 5. Miniature range with mouse trap devices	1. Realistic class size and individual sight and reticle devices. 2. Film on use of binoculars. 3. Films on fire adjustment and forward observation.			
Range Firing (a) Training shell (b) Range firing Ammunition expenditure ranges from 2 to 8 rounds HE per trainee.	1. Training shells (inert)	1. Training shell with smoke charge vials.			

TABLE 1(K)
THE 81 mm. AND 4.2 inch MORTARS

INSTRUCTIONAL TOPIC (1)	TRAINING AIDS		APPRAISAL OF THE MOTIVATION (EXTRINSIC) EMPLOYED (3)	FACTORS OF LEARNING (4)	INSTR
	Actually Employed (2a)	Needed (2b)			
Crew Drill	OTA's	1. Film	Marked absence of positive incentives. In view of the extended time devoted to these weapons, the 81 mm. especially, positive incentives in the form of easily attained goals (frequently available) are important. (For further discussion of this topic see Table 1(A) and pages 11-13 of the accompanying text.)	Practice: Highly massed. Certain phases of instruction appear to get insufficient opportunity for practice. Participation: Depends on weapons available and ammunition allowances. One round (81 mm.) per 2 trainees is probably insufficient, and 100 rounds Of 60 mm. per company (250 men) used as subcaliber for 4.2 inch is likewise inadequate for marksmanship practice. Knowledge of Results: Fair to poor. (For further discussion of this topic see Table 1(A) and pages 14-18 of the accompanying text.)	Class Size observed c present at assigned; present fo assigned. No. of Ins Appraisal: to provide tion and adequately results in ing consis and physic one post). instructio tive metho requires s tor person (For furt topic see 19-20 of
Gunner's Examination	Cook Demonstrator and OTA's	1. Film 2. Group size (working) models of sights for both weapons			
Technique of Fire	1. Group size M-10 Plotting Board 2. Miniature ranges 3. Burst markers (sticks) 4. Puff boards	1. Film			
Range Firing Ammunition expenditure (81 mm.): TP's....60-250 rds. per Co. HE's....1 rd. per 2 trainees 600 rds. per Co. Ammunition expenditure (4.2): 100 rds. 60 mm. per Co.	1. Training shell ammunition 2. Subcaliber (60 mm. mortar for 4.2)	1. Training shell with smoke charge. 2. In 4.2 subcaliber shells capable of reaching 4.2 ranges.			
M-10 Plotting Board	1. Group size plotting board	1. Participation films. 2. New device to train on M-10.			

OF LEARNING (4)	INSTRUCTOR-TRAINEE RATIO (5)	OBVIOUS DIFFERENCES BETWEEN TRAINING AND OPERATIONAL SITUATIONS (6)	COMMENTS (7)	PHASE II AND IMPLEMENTATION RECOMMENDATION (8)
...ssed - as much as ...w drill in one ...mount depends on ...ition availability. ...sults: ...pending on the ...lity and student and ability. ...; fair to poor; ...suell gives little ...f results; ...end to throw ...nts off. ...scussion of this ...(A) and pages ...mpanying text.)	Class Size: Smallest class observed consisted of 129 men present at problem out of 200 assigned; largest class was 321 present for training out of 375 assigned. No. of Instructors: 2 to 12, usually reverse ratio to class size. Appraisal: Generally inadequate to meet even minimum requirements for adequate instruction, control, and supervision. "County fair" type of instruction is a particularly appropriate method, but it requires and increase in instructor personnel. (For further discussion of this topic see Table 1(A) and pages 19-20 of the accompanying text.)	1. Terrain features in training vary markedly from those to be expected in combat. 2. Fractional settings are included in training although some indication they are not used in combat. 3. Insufficient (and possibly confusing) training on binocular and alidade utilization. 4. Field firing appears somewhat unrealistic in terms of targets used. (For further discussion of this topic see Table 1(A) and page 21 of the accompanying text.)	1. "County fair" type of instruction might be a good training technique. 2. Range estimation training appears inadequately mastered. 3. Early phases of instruction appear not to be mastered before proceeding to later topics. 4. Much of the training material is of an intellectual level above that of the average trainees. 5. Firing of a number of mortars into single small impact area tends to confuse knowledge of results about the firing of any one weapon. 6. Testing appears highly unreliable. 7. Sequence of fire commands are poorly, if at all, mastered.	Training procedures: 1. Job analysis of various phases of 60 mm. mortar marksmanship performance. 2. Determination of reliable measures of proficiency. 3. Determination of optimum class size (instructor-trainee ratio). 4. Determination of the optimum length of blocks of instruction and most effective distribution of practice. 5. Determination of effective methods of teaching skills which must be executed in a given order, such as, for example, the fire commands in mortar firing. Training aids: 1. Development and validation of smoke charge in training shells. 2. Development and validation of modified Cook Demonstrator to illustrate mortar shell trajectory. 3. Production of training films to teach crew drill, forward observation procedure, adjustment of fire, etc. 4. Development and validation of class size working mock-up of M-4 Sight. 5. Development and validation of realistic binocular reticle with target and burst indicator (group and individual size). Implementation suggestions: 1. Development of mortar firing ranges to permit adequate knowledge of results for each of several simultaneously used firing points.
- LEARNING (4)	INSTRUCTOR-TRAINEE RATIO (5)	OBVIOUS DIFFERENCES BETWEEN TRAINING AND OPERATIONAL SITUATIONS (6)	COMMENTS (7)	PHASE II AND IMPLEMENTATION RECOMMENDATIONS (8)
...rtain phases of ... to get insuf- ...y for practice. ... available and ...es. One round ...inees is prob- and 100 rounds ...any (250 men) for 4.2 inch ...iate for marks- ...ts: ...ussion of this ...(A) and pages ...mpanying text.)	Class Size: Smallest class observed consisted of 164 men present at problem out of 181 assigned; largest class was 322 present for training out of 358 assigned. No. of Instructors: 3 to 9 Appraisal: Generally inadequate to provide the necessary instruction and supervision. Lack of adequately qualified instructors results in mortar concurrent training consisting of close order drill and physical training (observed at one post). "County fair" type of instruction appears to be an effective method of instruction, but it requires some increase in instructor personnel. (For further discussion of this topic see Table 1(A) and pages 19-20 of the accompanying text.)	1. Lack of realistic ranges at which weapon is fired. (For discussion of this topic see Table 1(A) and page 21 of the accompanying text.)	1. Occasionally, where there was 81 mm. shortage, the 60 mm. was used. This may result in some confusion. 2. Insufficient 4.2 weapons for training. Some posts unable to give any instruction at all. 3. M-10 Plotting Board is too complicated for mastery within training time allotted. 4. Testing conditions (gunner's examination) lead to unreliable and spurious results. 5. Considerable discrepancy between time allotted to instruction per company and amount given per individual. 6. "County fair" instruction observed seemed to be fairly effective.	Training procedures: 1. Research on optimum time for blocks of instruction and most advantageous distribution of practice. 2. Determination of optimum instructor-trainee ratio for most effective learning. 3. Determination of job requirements and proficiency measurements for mastery of M-10 Plotting Board. 4. Development of job analysis and proficiency measures. 5. Research on personnel selection for mortar instruction. 6. Re-design and simplify M-10 Plotting Board. Training aids: 1. Development of group size working models of all mortar sights. 2. Development of smoke rounds for training ranges. 3. Production of films to teach technique of fire and M-10 Plotting Board. 4. Subcaliber shells capable of reaching realistic ranges. Implementation suggestions: 1. Employ positive motivational incentives. 2. Re-evaluation of the need for personnel selection for mortar training.

The tables are an attempt to summarize the most important material concerning marksmanship instruction obtained from the observations of training. The tabular summaries are presented under the following headings:

1. Instructional topic
2. Training aids
   a. actually employed
   b. needed
3. Appraisal of motivation (extrinsic) employed
4. Factors of learning
   a. practice
   b. participation
   c. knowledge of results
5. Instructor-trainee ratio
6. Obvious differences between training and operational situations
7. Comments
8. Phase II and implementation recommendations

The discussion to follow in this section will deal with the first six of the columnar headings.

1. Instructional Topic

The first column in the tables divides the weapon training into broad categories of instruction. Further sub-divisions were attempted, but they did not add significantly to the summary. It should be noted that no attempt was made to job analyze the instruction. One of the recommendations growing out of this survey is that a job analysis should be undertaken, but such activity is beyond the scope of the present project.

The instructional topics listed are taught by any one or a combination of the following methods: (1) the lecture, (2) demonstration, and (3) practical work. Although the word "lecture" does not appear anywhere on subject schedules, lesson plans, and/or any other training literature, there can be no doubt but that the lecture is the most frequently practiced method of instruction. Lesson after lesson was observed in which the principal instructor, wearing (or talking into) a microphone, lectured to classes of 150 to 300 men. This was referred to in official language as a "conference," on the rationalization that the instructor, in the last minute or two of the hour, would ask anywhere from one to three questions of individuals in the class or of the class as a whole. Whatever might be the official name given to this instruction, the fact remains that it conforms to the conventional definition of a lecture.

Demonstrations were usually incorporated in the lecture presentation. However, it should be borne in mind that the

class size frequently was in excess of two hundred men; hence it was not surprising that many men were unable to see the details of the demonstration. Moreover, the physical environment in which the training occurred frequently worked against effective instruction. For example, at some posts there was a shortage of public address systems, bleachers, and other facilities and equipment normally associated with mass-training situations; accordingly, it is probable that large numbers of trainees did not hear or see significant portions of the information presented.

Probably the most effective technique employed is the practical work---except for the fact that there were usually too few instructors to circulate among the trainees and to supervise the practical work. Accordingly, considerable reliance is placed on the principal instructor "talking through" the problem. That is to say, as the instructor calls out the operation or movement to be performed, the members of the class perform the specific task.

It has already been said that the practical work is the most effective technique employed. Insofar as "talking through" is at attempt to provide practical work---that is, to get the student participating in the training---it is a good instructional method. However, under present practices (large classes and insufficient supervisory personnel), "talking through" a lesson is, for all practical purposes, synonymous with "by the numbers" instruction. Unless qualified assistants in adequate numbers are provided, the instructor cannot know to what extent his instruction is being learned. Evaluation of instruction will be discussed in greater detail in a later section of the report under the heading of proficiency measures.

2. Training Aids: Actually Employed and Needed

The first half of column 2 in the tables deals with aids observed as actually employed during instruction. While a number of training aids and devices may be listed in local training aids catalogs or lesson plans, the entries under this heading are restricted to aids seen to be actually employed. As a result of this restriction, it can be said with some degree of certainty that, at present, most marksmanship instruction is presented with a minimum of training aids.

In general, the weapons themselves, or other operational equipment, are employed in the instruction. However, reliance on the weapon as a training device sometimes operates to limit the effectiveness of the instruction. For example, only two of the six installations visited had as many as five 4.2-inch mortars. At one post there was a serious shortage of 75-mm recoilless rifles (about ten or twelve) while a nearby National Guard unit was alleged to have about forty in storage. Still another post, with fifty companies undergoing various phases of instruction, reported only 57 M-10 plotting boards.

Furthermore, it is not enough merely to furnish the trainee with operational equipment, because the equipment is frequently not functional. For example, it was observed that during M1 rifle firing it was necessary to hand operate the bolt on large numbers of the weapons. . The Browning Automatic Rifle was also seen to be persistently malfunctional, and the condition of many other weapons which are constantly in use also leaves much to be desired.

In general, it appears that the reason for the extensive weapon malfunctions during training is that there is not sufficient servicing and examination of the weapons. The shortage of ordnance personnel to perform this function is emphasized by the fact that rarely are qualified ordnance personnel present on the training area to service weapons.

Closely related to the problem of weapon availability and condition is the availability of ammunition. In the absence of ammunition to fire, marksmanship proficiency can only be a matter of conjecture and inference rather than of demonstration and measurement. For example, one post visited was without any tracer ammunition; hence, all the instruction and practice which depend on tracer ammunition were close to meaningless. While the trainees did get to fire the machine gun at targets, they got no opportunity to adjust their aim by observing the strike of tracer bullets.

Subcaliber firing as a training aid. Ammunition allowances become particularly important when the weapons are of such size that the firing of many service rounds becomes expensive. Thus instructional practice firing with the mortars, the recoilless rifles, and the rocket launchers is seriously curtailed by ammunition cost and shortage. To overcome this limitation, some subcaliber devices are in use. In general, these are good as far as they go. However, some important improvements in the subcaliber devices are indicated. For example, present subcaliber firing with the recoilless rifles is highly unrealistic. Two important elements, the backblast and the noise, are missing during training. All that can be said with certainty about the training is that the trainees learn to fire .30 caliber ammunition with a 75-mm recoilless rifle. The 4.2-inch mortar is fired with 60-mm mortar ammunition as subcaliber; hence, the emotional factors (the danger and noise) are present in this situation. However, even this situation lacks some realism since the 60-mm mortar cannot be fired at the ranges to which the 4.2-inch mortar would normally be used.

It should be emphasized that under present practices and ammunition allowances, no 4.2-inch ammunition is fired during training. Under the circumstances, no 4.2-inch ammunition can be curtailed. Moreover, the fact that no service ammunition is expended means that marksmanship performance is, at best, only

a matter of conjecture drawn from the subcaliber firing. The question to be considered is whether or not the training objective is achieved. There is no doubt that at the present time proficiency on the 4.2-inch mortar is neither measured nor evaluated adequately. The discussion of proficiency measures, however, has been postponed until a later section of this report.

Some allowance should be made for the expenditure of ammunition for developing proficiency measures and for validating the effectiveness of various subcaliber devices and training procedures. If ammunition were available in unlimited quantities, it would be obvious that the best way to learn to fire a weapon is tc fire with live ammunition. With limited supplies of ammunition, the problem becomes even more important. Until reliable proficiency measures are developed and validated, the effectiveness of any increase or decrease in ammunition allowances cannot be assessed.

In the meantime, until the subcaliber devices are validated against reliable proficiency measures, sound principles of learning indicate that, wherever subcaliber devices are or can be utilized, they should provide those elements which are of training importance. Although noise and cues to danger can be omitted in early stages of training (where conceivably they might inhibit learning), they should be included at some point in the training where they might contribute to the learning.

Training films. Under the column headed "needed" training aids, there are listed, among others, a number of training films. Although a number of marksmanship films are indicated in SR 110-1-1, the observers saw only one film employed during training. That is to say that of the 1120 hours of instruction observed, only one hour included the showing of a film directly related to marksmanship. In view of the large number of films which are available, the many which should be used to advantage, and those which ought to be produced, it is discouraging to discover that almost none are used in marksmanship instruction.

It is possible that this situation stems from a statement contained in official Army literature. Specifically, Army Training Program 7-600-1 (Section I, paragraph 9b, dated 21 June 1951) reads:

> Training films and film strips are valuable aids to instruction. They should not be substituted, however, for other more appropriate methods of instruction, nor should they detract from the emphasis being placed on practical work.

As far as it goes, the statement is not a bad one. However, two important questions should be considered in this connection. First, what "more appropriate" methods of instruction are used in the Army? Second, why must it be assumed that the film substitutes for something else? Or, that the films would detract

from emphasizing practical work?

During the past several years, research has indicated that there are few methods of instruction---particularly in mass-training situations---more effective than instruction with film.* Moreover, research in recent years has demonstrated that films dealing with technical material are particularly effective aids to instruction when, among other characteristics, they provide for student participation during the screening. It is an error to consider that an instructional film is a training method in itself. It is, rather, an aid which the good instructor uses to increase the effectiveness of his teaching.

Probably the reason that films are not employed is that inadequate provision is made for their use. Accordingly, one recommendation which emerges from this discussion is that training installations should be surveyed to provide buildings, equipment, and efficient distribution facilities, all devoted to an increased use of training films.

It might be noted, parenthetically, that recent research concerning the role of television in the classroom indicates that this latest medium of mass communication may solve a number of the problems presently holding back the use of instructional films. Furthermore, television holds promise of value as an instructional technique. However, the utilization of television in marksmanship instruction is not anticipated for the immediate future. Accordingly, this report has been confined to instructional procedures and materials currently available.

The importance of this problem cannot be exaggerated. Thousands of men undergo Army training daily in groups ranging from 150 to 300 men each. The instructors, while for the most part willing, are not well prepared and qualified to teach. Some,

*As of this writing, the Instructional Film Research Program has issued some 22 technical reports covering experiments most of which employed film and no-film groups. The evidence that learning occurs from films is overwhelming. See especially the following: P. Ash, "The relative effectiveness of massed versus spaced film presentation," SDC-269-7-3; J. Zuckerman, "Commentary variations: Level of verbalization, personal reference, and the phase relations in instructional films on perceptual-motor tasks," SDC-269-7-4; W. S. Vincent, P. Ash, and L. P. Greenhill, "Relationship of length and fact frequency to effectiveness of instructional motion pictures," SDC-269-7-7; D. M. Neu, "The effect of attention gaining devices on film-mediated learning," SDC-269-7-9; N. Jaspen, "Effects on training of experimental film variables, Study I: Verbalization, rate of development, nomenclature errors, 'how-it-works', repetition," SDC-269-7-17.

indeed, appear to be only marginally qualified in the military professional sense. Furthermore, as already noted, the most frequently employed method of instruction is by the lecture in a physical environment which, charitably described, is less than ideal. Now then, if films have been found to be helpful to good instructors under the best of conditions, certainly there is reason to believe that the present Army instruction could be measurably improved with good training films.

Conclusions. Table 2 presents a complete listing of training aids which are recommended together with recommendations for further research (Phase II). This discussion on training aids, however, will be concluded with a listing of a few observations which are considered of paramount importance.

a. Few training aids or devices are used in marksmanship training. In view of evidence that training aids are valuable tools for instruction and learning, their extensive use should be encouraged. Usually operational equipment is used, but this frequently (and paradoxically) limits the effectiveness of instruction as a result of both weapon malfunctions and shortages and ammunition costs.

b. In general, the most frequently used aids other than operational equipment are graphic training aids. These were seen to be quite inadequate in size and, frequently, confusing in content. While these comments apply in a general way to all the posts visited, there is a wide variation between posts---even between units within a single post---in the degree to which the generalization applies.

c. Devices are needed which will provide the trainee with practice under as realistic a situation as possible together with meaningful and immediate knowledge of results.

d. A device is needed which will provide meaningful and immediate knowledge of results when the operational equipment itself is used.

e. A number of films are available which are not used. In addition, new films should be produced which will include such factors as student participation.

3. Appraisal of the Motivation (Extrinsic) Employed

By extrinsic motivation is meant incentive conditions outside of the trainee (reward and punishment) which are determined by the instructor or the training environment. This is to be distinguished from intrinsic motivation by which is meant conditions which are within the trainee (desire to achieve, willingness to

TABLE 2

SUMMARY OF TRAINING AIDS NEEDED

WEAPON	TYPE OF TRAINING AID RECOMMENDED	PHASE II AND IMPLEMENTATION RECOMMENDATIONS
All Direct Fire Weapons	1. Device which gives knowledge of results in dry firing. 2. Device which automatically scores and yields immediate knowledge of results in wet firing. 3. Training films for orientation and technical instruction. (Participation-type films for the latter.)	1. Development and validation of a knowledge of results device which indicates bullet strike on 500 or 1000 inch targets during dry firing practice. 2. Development and validation of an automatic and reliable scoring device for all wet firing situations which also yield immediate knowledge of results to the shooter. 3. Production and validation of training films on all phases of marksmanship instruction. Special emphasis to be placed on the development of participation-type films to provide for trainee practice.
All Weapons (when used in tracking moving objects)	1. Device which gives both elevation and deflection tracking practice simultaneously.	1. Development and validation of realistic moving targets whose movements vary simultaneously in both vertical and horizontal dimensions.
M-1 Rifle	1. Device to check reliably and accurately individual's ability to get correct sight picture. 2. Device to give visual and kinesthetic (i.e., muscle-sense) information and training on trigger squeeze (individual size). 3. Group size working model of M-1 rear sight to show corrections.	1. Development and validation of: (a) instruments to measure an individual's sight picture and sighting behavior. (b) individual trigger squeeze device which gives kinesthetic and visual knowledge of results. (c) working model of M-1 rear sight (group size) for instruction on sight changes.

TABLE 2 (Cont.)

SUMMARY OF TRAINING AIDS NEEDED

WEAPON	TYPE OF TRAINING AID RECOMMENDED	PHASE II AND IMPLEMENTATION RECOMMENDATIONS
All Mortars	1. A training shell for use on training shell range which contains small smoke charge and which explodes on contact. 2. Training films for orientation and technical instruction (participation-type films for the latter). 3. Modified Cook Demonstrator to show shell trajectory (all mortars). 4. Group size working model of sights. 5. Long range subcaliber ammunition for 4.2-inch mortar.	1. Development and validation of training smoke shell for use in training shell range practice in Forward Observation Procedure. 2. Production and validation of training on all phases of mortar instruction. Films to be produced in light of recent research findings of providing for trainee practice and participation during film showing. 3. Development and validation of: (a) modification of Cook Demonstrator to demonstrate more effectively the relationship of shell trajectory to sight and barrel changes. (b) group size working model of sights to give knowledge of results to class problems. (c) subcaliber ammunition for 4.2-inch mortar capable of reaching realistic ranges.
Browning Automatic Rifle	1. Device (individual) to teach trigger "press" and which provides kinesthetic and visual knowledge of results.	1. Development and validation of an individual size trigger squeeze device which gives kinesthetic and visual knowledge of results.
Grenade Launcher	1. Training shell which contains small smoke charge which explodes on contact yielding knowledge of results.	1. Development and validation of training shell which contains small smoke charge which explodes on contact yielding knowledge of results.

TABLE 2 (Concl.)

SUMMARY OF TRAINING AIDS NEEDED

WEAPON	TYPE OF TRAINING AID RECOMMENDED	PHASE II AND IMPLEMENTATION RECOMMENDATIONS
Rocket Launcher	1. Three-dimensional device (group size) to teach principles of boresighting.	1. Development and validation of three-dimensional device (group size) to facilitate teaching the principles of boresighting.
Recoilless Rifles	1. Three-dimensional device (group size) to teach principles of boresighting. 2. Inert service round for loading practice. 3. Sight picture devices for effective instruction showing target-distance perspective. 4. Subcaliber device which provides realistic backblast and noise as well as projectile capable of firing.	1. Development and validation of three-dimensional device (group size) to facilitate teaching the principles of boresighting. 2. Utilization of inert service rounds in loading practice. 3. Modification and validation of existing sight picture device to demonstrate effectively target-distance perspective. 4. Modification and validation of presently used subcaliber devices to provide realistic backblast and noise.

learn, zeal to excel, etc.). Extrinsic motivation can be observed and its effect evaluated; intrinsic motivation, because of its subjective nature, cannot be so readily observed. Accordingly, this survey is limited to overtly applied and observable extrinsic motivation.

Recruits in the Army arrive at the training area with varying degrees of motivation to learn. There are some who have a drive to learn all they can, and some of these are driven by an ambition to excel (perhaps to qualify for OCS training) over others in the company.

The opposite extreme is the group, which may be small, which is determined not to learn at all. It is important to remember, however, that men who fail to learn are not necessarily deliberate in their failure; they may lack the required educational background and/or capacity to learn the material. However, in the military training situation---in which large numbers of men are drafted into service---there are certain to be some men there against their will.

Between these two extremes of the intrinsically highly motivated and the deliberately negatively motivated, there are individuals who represent the entire range. Thus, if measurement were undertaken, it would probably be found that some recruits are indifferent---they will learn, but they are not eager---while others will be more and some less eager to learn.

The experience of most teachers is that the more highly motivated the trainee, the easier it is to teach. However, motivation is a delicately balanced mechanism. It is not static; it can and does change easily from moment to moment.

Because motivation is so subject to change by environmental pressures, extrinsic incentives are extremely important elements in a training situation. It should be remembered that what is done in the name of motivation can work either for or against the desired end.

Accordingly, column 3 of Table 1 was included in the hope that the observations of training would uncover practices which heighten in a positive (i.e., desirable) direction the trainees' inner desires to learn. Unfortunately, the best that can be said is that what incentives are provided are haphazard and inconsistent. There is a marked absence of positive incentives, and the emphasis appears to be on punitive discipline. Thus it was observed that, during the 10-minute class "break," recruits were required to do "push-ups" as punishment for defections such as falling asleep during the lecture or having their pocket flaps unbuttoned.

This is not intended to be a philosophical discussion about the need or advisability for discipline and disciplinary measures.

The only concern here is whether or not these measures have been applied at the proper time. Present knowledge of the effect of punitive action in a training situation leads to the generalization that the trainee will most likely undergo an emotional upset which will interfere with his learning. Moreover, it must be considered that the effect of punishment is somewhat unpredictable. Positive (rewarding) incentives are better than negative ones.

Except in isolated instances, nothing of a positive nature is applied to heighten motivation. The practices which are generally employed can only be appraised as highly inadequate and too likely to depress the students' desires to learn. Only in rare cases is there inter-squad or inter-individual competition with a real and relatively immediate rewarding goal to be achieved. One such case was observed during mortar instruction. The class was divided into four teams, and the team which laid out the mortars most accurately and rapidly was declared the winning team. The slowest was the loser and policed up the weapons of the winners while the latter enjoyed an additional 10-minute "break." At another post, the five highest scorers on the mortar gunner's examination were awarded, in mock-ceremonial fashion, medals made from the ends of tin cans to which ten-cent store ribbon was affixed.

The instances of applied imagination in this area are so rare that these two stand out as almost isolated cases. Except for these, extrinsic motivation was observed to be missing from the instruction to a marked degree. In order to exercise control over the men, only strict disciplinary measures were applied during the learning periods. Such measures, in general, are of questionable value. There is reason to consider, moreover, that punitive discipline during training periods affects the training in a negative direction.

Also weapon shortages and malfunctions probably have an adverse effect on motivation. There is perhaps no strong desire to learn to use a weapon which is seen to be persistently malfunctional even during training sessions.

Still another factor affecting motivation is the apparent lack of official concern about the need for inclement weather schedules. Another factor is found in poorly qualified and disgruntled instructors who certainly (though not necessarily intentionally) militate against a desirable learning environment. As long as "pipe-line" personnel (i.e., "transient" personnel destined for transfer to other duty) are utilized as instructors---sometimes against their wishes and frequently in the absence of any qualifications to teach---the training and learning are likely to be adversely affected.

Finally, although M1 rifle qualification scores are posted, they may have less effect on motivation than might be expected. There is no concrete evidence that large numbers of men qualify

by the ".30 caliber pencil," but there is sufficient talk about it to consider it a possibility. Cheating is possible, and if it does occur, motivation to learn may give way to achieving high scores by other means.

A further point should be considered in the matter of M1 rifle scores. Assuming that the scores are valid and honestly achieved, this question might be asked: What is done with the scores? Aside from awarding a medal to qualified men, nothing is done. The only people affected are the "bolos." Insofar as official Army records are concerned, these unqualified men represent only a small fraction---15% to 20% at most---of the trainees. Unqualified men are required to refire the course or take parts of the instruction over. Or, and this is what makes the scheme appear invalid, nothing is done. What then is the motivation to succeed? At best it is only an individual's desire to identify with his group and not to be singled out as a failure. The emphasis is a negative one, since the incentive operates to bring the motivation only up to a minimum level. What is required are incentives which will make the trainee want to achieve his highest level of proficiency.

4. Factors of Learning

Of particular interest in this review was an evaluation of the degree to which basic learning principles were applied in marksmanship training. The following discussion, therefore, will deal with problems related to (a) individual differences among trainees, (b) massed and spaced practice, and (c) knowledge of results.

Problems related to individual differences. An implied objective of marksmanship instruction is to train Army recruits to a common level of proficiency. In other words, the objective is a relatively "standardized" end-product. The implicit hope is that each man will be able to take the place of any other man in the organization.

To achieve the objective of a standardized end-product, the Army's present scheme of instruction is to provide standardized instruction for all men. The rationale is that, if all men get the same instruction in the same way, they will all be equally trained. Unfortunately, this is neither logically nor practically correct. Of course, in the absence of adequate measures of proficiency, it is difficult to do more than make a subjective judgment about this policy based on the observations of the training. These judgments lead to the conclusion that many trainees fail to master---indeed, to grasp---elements of the material included in the training. This is the result, in large measure, of the fact that many men are taken through the training at too rapid a pace, while still others do not have the necessary intelligence and educational background to profit from the instruction, even if it were slowed down significantly. Accordingly, the

end-products achieved by the present program of instruction vary considerably (from zero on up) in ability to perform the tasks.

Since individuals vary in capacity to absorb instruction, a training program is required which is flexible and varied in its pacing, content, and practice; in short, it should be geared to the students' abilities and rates of progress. Although it cannot be expected that everyone can be made equally proficient, the degree of variation can be controlled somewhat by providing a greater degree of varied (and individual) instruction.

At present the official implied (and sometimes expressed) position is that the instruction is geared to the "average" or "middle" group of students. However, there is no evidence that any attempt has been (or is being) made to determine what the level of capacity is of a "middle" group. On the contrary, the content of instruction, the amount of material to be covered, and the time devoted to each subject appears to be little more than arbitrary selection handed down from "on top." Accordingly, the programs of instruction in the various weapons become highly rigid and stylized presentations of material with a minimum regard to the degree of actual learning. The result is not standardized trainees but rather recruits with greatly varying degrees of proficiency.

There is some implicit recognition of the need for individualized training by the Army's use of the coach-and-pupil method of instruction. In the ideal application of this method, a qualified firer---and qualified instructor---observes a trainee's performance and corrects errors as they occur. The method (as used in the Army at present) fails to achieve the desired result because the coach is no better qualified to give instruction than his pupil.

Only one military training installation was observed to give instruction on the M1 rifle using "permanent" and specially-trained coaches, one to each firing point on the line. Under this scheme, a given coach seldom had more than six to ten trainees to teach during any one period; hence, he came to know "his" students and was able to follow them through all their firing, giving immediate attention and assistance to firing problems.

Moreover, certain current Army policies and practices militate against adequate provision for individualized instruction. These are: (a) classes ranging in size from 150 to 300 (or more) trainees with an average of four or five instructors, (b) student participation which involves "talking through" and "by-the-number" instruction usually leaves the slow student behind in the training, (c) heterogeneous grouping of men in terms of ability to learn the material, and (d) marked tendency for the contents, schedules, and methods of instruction to be highly inflexible regardless of any given group's learning progress. This last occurs because of the absence of valid and reliable proficiency measures which, if applied,

would probably indicate that the amount of learning falls far short of the amount of instruction given.

It should be noted, however, that some training procedures are currently utilized which do mitigate, to a degree at least, the effect of individual differences among the trainees. These are: (a) assistant instructors whose primary responsibility is to circulate among the trainees to give them individual attention, (b) special after-duty hours of instruction for recruits who have special problems, and (c) a "county-fair" method of instruction in which relatively small groups of men go from one phase of instruction to another, each one taught by a different instructor.

Of these, the last appears to be the most promising. Dividing the class into smaller groups tends to reduce the instructor-trainee ratio, thereby providing greater opportunity for instructor-student communication on a face-to-face basis. This method is distinguished here from what is commonly referred to as "concurrent training," because in the "county-fair" method each topic of instruction is of equal importance. The roving assistant instructors, referred to in (a) above, are of limited value. The observations of this kind of instruction indicate that unless each instructor feels and has a real responsibility to a group of trainees, he is likely to roam around giving only haphazard assistance. This means that the principal instructor has the task of not only supervising the instruction but also supervising the efforts of his assistants. Finally, (b) above is of extremely dubious value, because it is difficult to know when extra hours could be found for such instruction. The schedule of instruction is so excessively crowded now that it would not be desirable to add to it further. Moreover, the regularly scheduled training sessions suffer from a shortage of qualified instructors; hence, it is difficult to envision the kind of instruction which could be given at other times, such as during the evening.

An outgrowth of this discussion is the recommendation that research be undertaken to determine ways in which the variations of proficiency between individuals can be measured and effective training techniques developed which take into account these individual differences. Obviously, this means that a concomitant research project would be the development of proficiency measures to determine effectiveness of the present and any revised training program.

Problems related to the massing of training. In general, weapon instruction appears to be excessively massed into single large blocks of practice. It was not unusual to find, for example, that all mechanical training on a gun was taught in one day in a single six to eight hour session. This was also true of preliminary marksmanship. The instruction on the M1 rifle, for instance, is usually divided into three major topics, namely, mechanical training, preliminary marksmanship instruction, and firing for

practice and record. As already noted, the first is frequently taught in one or two days of concentrated instruction. The second phase, preliminary rifle instruction, occupies approximately twelve to fourteen consecutive days of concentrated instruction on trigger squeeze, position excercises, breath control, scorebook-keeping, sustained fire (dry), and sc forth. Finally, after about sixteen days, the trainee is permitted to fire the weapon. This too is concentrated into three to three-and-a-half consecutive days of firing.

Still another example can be found in mortar training; six to eight consecutive hours (usually within a single day) are devoted to preparation for, and administration of, the gunner's examination. It can only be noted that such massing of practice or instruction usually has the effect of fatiguing and boring both students and instructors. Moreover, it should be pointed out that such massed instruction has usually been found to be poorly retained for an extended period of time.

Experiments in the field of educational psychology indicate that, in both verbal and motor-skill learning, spaced practice is more effective than massed for retention of learning. Since it is clear that the Army is not concerned with training recruits for short-term proficiency, the present instruction schedules should be examined to find ways in which the instruction could be divided into more effective spaced periods of practice. It might be suggested, for example, that the Ml preliminary rifle instruction be broken up by periods of interpolated firing practice. Thus instead of all the firing occurring in three consecutive days with approximately three hundred rounds of ammunition, it would be more effective if brief firing sessions were introduced after instruction on each of the various firing positions. For example, it is almost certain that, instead of three hundred rounds in three days, a more effective distribution of practice would be thirty rounds per day for ten days. It remains for experimentation to provide the answer to the question of what is the best distribution of practice.

It is desirable that each of the infantry weapons be individually studied to find the most effective length of time to be devoted to various phases of marksmanship. A reliable and valid measure of proficiency should include the retention of the skill over extended periods of time, not just immediately after the instruction. While such a study should be undertaken as a research and development program, its implementation requires careful and informed supervision.

Problems related to "knowledge of results." By knowledge of results is meant presentation of information to the learner that a response he has made (verbal or sensori-motor, such as answering a question or firing at a target) is correct and accurate (or incorrect and inaccurate). It has been demonstrated

at practical, experimental, and theoretical levels of investigation that giving a learner such knowledge of results immediately following his response has a significant positive effect on learning. Moreover, the more meaningful the knowledge of results, the greater will be the facilitating effect on learning. Furthermore, there is experimental evidence that in the absence of knowledge of results there is a significant deterioration of learning.

In general, much marksmanship instruction in the Army is distinguished by the absence, or substantial delay, of knowledge of results. There is, during instructional practice firing, some knowledge of results provided by tracer ammunition, marked targets, and correction of errors by assistant instructors. The real value of tracer ammunition during practice firing is not fully known. However, in both firing and dry-firing practice, there is a marked delay, or absence, of information which might guide the student in the correction or reinforcement of his last response.

With the exception of triangulation exercises during preliminary rifle instruction, all forms of dry firing failed to give any meaningful knowledge of results. Thus a trainee is likely to put forth only enough effort to satisfy the watchful eye of the instructor. Since he has no information which tells him that his efforts are either right or wrong, there is no reason for the trainee to assume that he has not mastered the skill and that he needs more practice. Certainly the recruit realizes that the "coach," his fellow recruit, has no more information than he has to determine the correctness of his movements.

Accordingly, a major recommendation is for the development of devices suitable for outdoor use which will give the trainee immediate, shot-by-shot, information of where the bullet would have struck had he been firing live ammunition. Still another device is required for use with live ammunition to provide the trainee immediate information that his shot did (or did not) strike the target at the point aimed at. The simplest type of target would be one which would break and shatter when struck. However, it would be desirable that the student should know where the bullet did strike if the shot was a miss. Finally, the targets should be immediately replaceable to minimize delay between shots fired. The ideal type of target would be one which automatically would provide the trainee with immediate and meaningful knowledge of the progress he is making in learning marksmanship.

It should be emphasized that these devices should be developed for use in early as well as late stages of training. It is important that the student should be apprised of his learning progress as early in the instruction as it is meaningful to include such information. At the present time knowledge of results is missing not only from early stages of learning but also from late phases of practice. For example, there is, at best, only delayed information in the squad distribution and assault firing problems. During these problems, the standard operating procedure is to score the

problem at the completion of all firing. This delay has the effect of making the information, when it is given, almost meaningless---particularly when the trainee has no further opportunity to reinforce or correct his work.

5. Instructor-Trainee Ratio

The column headed "Instructor-Trainee Ratio" summarizes and attempts to appraise size of classes observed relative to the number of instructors per class. It was noted that classes ranged in size from 150 to 300 trainees. The number of instructors (principal instructors plus assistants) in attendance ranged from three to six.

It is conceded that certain instructional topics can be taught effectively to large groups of students (when adequate facilities are available). Such topics usually comprise general information and non-technical material. However, repeated instances were observed in which a lone instructor attempted to lecture to a company-size group without the aid of a public address system, without legible graphic training aids, and without bleachers for the class, to mention but a few of the handicaps. Moreover, interfering noise and activities in adjacent training areas competed for the trainees' attention.

Assuming that the necessary facilities and equipment are available for the instruction of large classes, there are still large numbers of training topics which, with current instructional materials, cannot be successfully taught on a mass-instruction basis. The section immediately preceding has already discussed the importance of individualized instruction and need not be amplified further except to mention the obvious fact that the degree of individualized instruction is a function of the instructor-trainee ratio.

It would be well to consider here some other pressing problems which are related to the central problem of the ratio between instructors and trainees. First is the problem of trainee absences from instruction. During the observations the absences regularly averaged from 15% to 20% of the company strength. An examination of the causes for the absences provided the following: (a) sick call, (b) kitchen police and guard duty, (c) classification and assignment interviews, and (d) other miscellaneous reasons, such as AWOL's and prisoners.

Some absence from instruction is to be expected. However, every effort should be made to keep it to a minimum. In any case, where the percentage is as consistently large as it has been found to be, special provision should be made to have "make-up" instruction. At present, the only available time for make-up training is during Commander's Time and after-duty hours. In view of the fact that a trainee's time is fully accounted for in the regular

schedule, it is clear that he could not logically join another company for instruction on a specific topic without missing still another lesson for which he is scheduled during the same hour. As for Commander's Time, it would appear that company commanders are already faced with insufficient time for the activities which are necessary, such as inspections, weapon cleaning, etc. In any case, make-up instruction during both Commander's Time and after-duty hours is likely to be limited by the shortage of instructional personnel qualified to give the training.

Although no systematic search was made to determine the extent to which make-up training was provided, such instruction was not readily apparent. Moreover, the informal search which was made during the observational visits led to the conclusion that make-up instruction is clearly inadequate---if, indeed, it exists at all. It should be stated at this point that this discussion does not apply to men transferred to another company after missing more than three days of consecutive instruction due to illness.

At least one suggestion can be made to minimize the adverse effect of absenteeism: implement as many controls over the causes of absenteeism while at the same time providing regularly scheduled and adequately staffed make-up periods of instruction.

In considering the problem from the point of view of the number of instructors involved in the ratio, a number of problems present themselves for consideration. Certainly the most urgent problem stems directly from official Army policy and practice relative to instructional personnel. At the present time, instructors at infantry training installations are, for the most part, "pipe-line" personnel. That is, they are performing instruction duties while awaiting orders to something else. The quality of the instruction---and it follows, logically, the end-product also---suffers from this rotation program to a perceptible extent. One of the posts visited reported that the turnover of instructional personnel was 120% in the last year. At this same installation there was found the extreme case of one company having a change of commanding officers six times within the sixteen-week cycle of training. Not only are instructors rotated at these rapid rates, but also they are provided in inadequate numbers. An example of this situation was found at one post which, at the time of the visit, had 52 companies in training (a total number of trainees in excess of 10,000) with only a total (officers and enlisted men) of 113 instructors whose primary duty was weapon training. This installation was so hard pressed for personnel that one assistant instructor was always missing from the training area because he was assigned to kitchen police duty that day. Moreover, the shortage was such that the instructor was assigned KP duty even though he was a non-commissioned officer.

It is submitted that such a situation is serious enough to require immediate attention and steps taken to solve the problem.

Considerable time and experience are required for an instructor to become familiar enough with the material of training to be really effective in the task of instruction. While no time limit can be placed for such an in-service period, it is clearly evident that the majority of instructors in infantry training are rotated long before they have even begun to develop any teaching proficiency. This was clear during the observations and is reflected in the quality of recruits who are trained by these instructors. Again, no verification was readily feasible, but it was generally conceded that the average length of a tour of instructor duty at the training divisions was approximately three to four months. Anyone who remained as long as six months was enviously referred to as a "homesteader." This situation adversely affects the training from the source of instruction, because the morale of the instructor is reflected in his teaching. Moreover, he feels no desire to develop procedures and materials of instruction which might improve the training, because he feels that he will be on the job too short a time to put any plan into operation.

A good training program requires, first and foremost, an instructional staff of well-qualified men in adequate numbers. The individual instructor cannot be blamed for expending only minimum effort when he is faced with short-term duty on a post where he is daily faced with such personal problems, to name but one, as a shortage of housing.

Accordingly, it is recommended that this entire problem be considered and examined to an extent beyond the scope of this present report. Although, as indicated, the problem is outside the purview of this study, it should be clear that the matter cuts across and affects all training effectiveness. Since this is the case, the problem should be faced, and if possible, solved.

6. Obvious Differences Between Training and Operational Situations

In the absence of clearly defined performance criteria, the findings of the survey cannot do more than suggest that certain practices were observed which should be examined further for their apparent lack of transfer value from the training situation to the operational one. Moreover, the problem becomes doubly important if, as it sometimes appears likely, the instructional situation makes the trainee dependent upon certain behavior "cues" which are unlikely to be present anywhere except in training. Accordingly, it was considered advisable to draw attention to those practices which are clearly open to question. These procedures have been included in Table 1 under the heading, "Obvious Differences Between Training and Operational Situations." It should be noted that while these problems are "obviously" open to question, research may indicate ultimately that the differences observed have no significance. However, only systematic investigation can establish whether or not specific items listed are of importance.

For example, present marksmanship training involves extensive use of clearly defined targets, and a trainee's task is to fire at these readily visible (types E and F) targets. Rarely does the trainee have to pick out and fire on partially concealed and poorly defined targets. Accordingly, subject to verification, it is hypothesized that firing on readily perceived targets fails to prepare the soldier adequately for the types of targets which he is likely to encounter in combat.

Another example of employed learning "crutches" which may have a negative effect on later behavior was observed in the emphasis placed on "match competition" firing positions. For instance, pistol marksmanship is taught with the classical "match" standing position. Likewise, in M1 rifle instruction, it was observed that trainees were directed to "mark" their heel and elbow positions on the ground so that they could return quickly to this position. These practices do not appear like those which can be expected under less artificial conditions.

Since research has indicated that maximum transfer can be expected from close similarity between training and operation, and that transfer falls off as dissimilarity grows, it is recommended that the entries under this column of the table be systematically evaluated to increase the similarities which can be found to affect the transfer value of training.

SECTION III

PROFICIENCY MEASURES

Table 3 is a summary of the observations and judgments relative to the evaluation of training and the measurement of proficiency.

Column 1 of Table 3, entitled, "Weapon or Topic," comprises a listing of specific weapons or groups of functionally related weapons. In the case of the 4.2-inch mortar, entries consist of instruments or procedures which, while not weapons, are skills and procedures incidental and concurrent to marksmanship performance with the mortar.

Column 2, "Type of Firing and Ammunition Allowances," indicates the kinds of firing situations observed as well as incomplete data concerning the amounts of ammunition expended or available for the firing. The reason that more complete information could not be gathered was that ammunition expenditures appear to vary considerably from post to post. Moreover, it was seen to vary from day to day on any given post. For example, at one post, at the

TABLE 3
SUMMARY OF MEASUREMENTS OF MARKSMANSHIP PROFICIENCY

WEAPON OR TOPIC	TYPE OF FIRING AND AMMUNITION ALLOWANCE	TRAINING OBJECTIVE	SUBJECTIVE (OBSERVER) ESTIMATION OF TRAINING SUCCESS	ARMY (OFFICIAL) RECORD OF SUCCES
M-1 Rifle	Proficiency (KD and transition) firing Ammunition: 219-321 rds/man	Qualification as "expert," "sharpshooter," or "marksman"	Fair (subject to verification)	Record ranges from: (a) 60%-marksman or better post) (b) 80%-100%-marksman or t most posts) (c) 90%-experts (at one p
	Familiarization (500 and 1000 inches) firing	Instructional practice	Fair (subject to verification)	None
Browning Automatic Rifle	Familiarization (500", KD, and transition) Ammunition: 36-70 rds/man	Instructional practice	Fair to poor (subject to verification)	At one post, sampling (50 cated approximately 60% qu marksman or better. This project.
Carbine	Familiarization (500" and/or transition) firing Ammunition: 25-30 rds/man	Instructional practice	Fair to poor (subject to verification)	None
Pistol, .45 caliber automatic	Familiarization (15 and 25 yds.) Ammunition: 30 rds/man	Instructional practice	Poor (subject to verification)	None
Submachine Gun	Familiarization (15 and 25 yds.). Occasionally a transition course. Ammunition: 0-30 rds/man	Instructional practice	Poor (subject to verification)	None
Grenade Launcher	Familiarization (transition-type) Ammunition: 1-3 rds/man	Instructional practice	Poor (subject to verification)	None
Rocket Launcher	Familiarization (transition-type) Ammunition: 1-3 rds/man	Instructional practice	Poor (subject to verification)	None
Recoilless Rifle	Familiarization (transition-type) Ammunition: 20-64 rds/man (.30 caliber used as subcaliber only); 1 rd/man service ammunition	Instructional practice	Fair for subcaliber; service caliber unknown	None
Machine Guns (a) Heavy (b) Light on tripod (c) Light on bipod (d) .50 caliber	1. Record (500" for light and heavy) 2. Familiarization (transition-type) .30 caliber machine gun with tripod, ammunition: 48-162 rds/man; .50 caliber machine gun, ammunition: 10-30 rds/man	Instructional practice	Fair to poor (subject to verification)	80-85%-marksman or better men at one post on tripod guns. 45-50%-marksman or bipod mounted guns (50 men No record on .50 caliber r
Mortars (a) 60 mm (b) 81 mm	1. Training shell range, ammunition: 2 rds/3 men 2. Field firing, ammunition: 3-6 rds/man	Instructional practice	Fair to poor (subject to verification)	
(c) 4.2 inch	Subcaliber firing only Ammunition: 100 rds/company of 60 mm (at one post)	Instructional practice	Poor	None
(d) Binoculars and alidades	(Not applicable)	Instructional practice	Fair to poor	None
(e) M-10 Plotting Board	(Not applicable)	Instructional practice	Generally poor	
(f) Gunner's Examination	(Not applicable)	Instructional practice	Fair to poor	At one post only 20% succe

...CCESS	ARMY (OFFICIAL) RECORD OF SUCCESS	RELIABILITY OF OFFICIAL RECORD		PHASE II RECOMMENDATIONS
		Factors Affecting Reliability	Appraisal	
...n)	Record ranges from: (a) 60%-marksman or better (at one post) (b) 80%-100%-marksman or better (at most posts) (c) 90%-experts (at one post)	1. Weapon reliability 2. Reliability of scorer 3. Test administration 4. Weather conditions 5. Ammunition reliability	Low to moderate	1. Development of automatic scoring device 2. Development of reliable test administration procedu 3. Research to determine effect of various weather cor tions on scores 4. Research to determine whether scores which could be derived from familiarization firing are indicative learning
...n)	None			
...ifi-	At one post, sampling (50 men) indicated approximately 60% qualified as marksman or better. This was special project.	Same as M-1 (above)		Same as above
...ifi-	None			Same as above
...)	None			Same as above
...)	None			Same as above
...)	None			Same as above
...)	None			Same as above
	None			Same as above
...ifi-	80-85%-marksman or better (sample 50 men at one post on tripod mounted guns. 45-50%-marksman or better on bipod mounted guns (50 men sample). No record on .50 caliber gun.	Same as M-1 Rifle (above)		Same as above
...ifi-		None for firing. Informal evaluation of gunner's examination (at one post) indicates approximately 20% success.		Same as above
.....	.....	.....	.....	.....
	None			Same as above
.....	.....	.....	.....	.....
.....	None	.....	.....	1. Evaluation of instructional techniques (present) covering these instruments. 2. Development of training procedures and aids. 3. Development of proficiency measures.
.....	.....	.....	.....	.....
	At one post only 20% success	Same as M-1 Rifle (above)		1. Development of reliable testing procedures. 2. Determination of effect of various weather condition 3. Job analysis and development of proficiency measures

time of the observation, a total of seventy rounds of .30 caliber ammunition was fired by each trainee with the Browning Automatic Rifle. At still another post, as a result of ammunition shortage, only 14 rounds were fired for the same lesson (seven for practice and seven for record). Several days later, the same lesson was visited at the second post and this time 36 rounds per trainee were fired (18 for practice and 18 for record).

Still another example of the range of ammunition expenditure was observed during 57-mm recoilless rifle practice-firing. At one post all the instruction on the 57-mm recoilless consisted of a four-hour lesson on mechanical training, but no firing of either subcaliber or service ammunition; at a second post, the instruction included twenty rounds of subcaliber (ten in kneeling and ten in prone positions), but no service rounds; a third post provided practice by permitting each trainee to fire two rounds subcaliber (although twelve rounds per trainee were available and drawn for the lesson) plus one round of service ammunition; finally, at still another post, 64 rounds subcaliber per student were fired, but no service ammunition. In the case of the post which fired one round of service ammunition per student, word had already been received that, for the second quarter of 1952, only one round of service ammunition per four students would be available.

The importance of these data will become clearer as the discussion turns to a consideration of the "type of firing" as related to the next column in the table, namely, "Training Objective." It will be clear from Table 3 that, insofar as the observations are concerned, the training objective is stated as "instructional practice." Only the M1 rifle is fired for proficiency and the measurement thereof. Parenthetically, it is noted that at one installation the 57-mm and 75-mm recoilless rifles were fired with subcaliber ammunition for proficiency testing. With this one exception, it appears that all firing with all weapons other than the M1 rifle is for "familiarization," or instructional practice. The point to be noted is that, in spite of the considerable range in ammunition expenditures, it is not possible to determine by present practices and procedures which installations achieve the training objective and which fail. The reason for this situation is that there is not a definite and measurable criterion of proficiency. "Familiarization" is too loose a term to serve as a training objective; nevertheless, an examination of lesson plans indicates that the purpose of many firing exercises is "to familiarize the student with firing the [weapon]."

Manipulation of ammunition allowances and expenditures has little or no meaning as long as the effectiveness of any given expenditure is not reliably measured. Until systematic analysis is made of the task (skill) involved in the accurate and rapid firing of a given weapon, the effectiveness of any given number of rounds fired in practice cannot be determined. Moreover, until such effectiveness is determined, there is no way to ascertain the

effect on proficiency of either increases or decreases in ammunition allowances. The truth of this observation can be seen by referring back to the earlier examples of the post-to-post variations in ammunition expenditures. Who can say that the post which fires twenty rounds per trainee of subcaliber is achieving the objective of "familiarization" to a lesser degree than the post which allows seventy rounds per student? Moreover, who can say that an unlimited practice allowance of .30 caliber ammunition will result in accurate and rapid proficiency with 57-mm service ammunition?

In short, the points which Table 3 and the preceding discussion make are: (1) no reliable measures of proficiency are available, (2) no measurable definition of marksmanship proficiency is provided, and (3) until reliable proficiency measures are developed and validated, additions or subtractions to training ammunition allowances can only be a matter of arbitrary choice whose effect cannot be determined by present practices, policies, and procedures.

Column 4 in Table 3, "Subjective (Observer) Estimation of Training Success," and the entries therein emphasize the difficulty of making judgments concerning the effectiveness of the firing practice as it was observed. In the absence of systematically derived objective proficiency measures, only subjective estimates can be made of training success. Accordingly, the considered judgments of the observers are that the training poorly, or at best only fairly, achieves the objective stated in the Army Training Program (No. 7-600-1, dated 21 June 1951). The objective is to train the soldier "...to fire proficiently any individual weapon (M1 rifle, automatic rifle, carbine and pistol, etc.)...and serve as any member of the crew of a crew-served infantry light weapon...." Again, after proficiency measures have been developed, these judgments will be subject to verification.

Column 5, "Army (Official) Record of Success," again illustrates the fact that good proficiency measures are not available. The only record which is kept is the trainees' M1 rifle qualification scores. Aside from this one weapon, only informal records were available for examination on the machine gun and the automatic rifle. For example, the results of a locally conducted investigation at one post with a sampling of fifty men on the automatic rifle indicated that only 60 per cent of the men qualified as marksmen or better. A similar project on the machine guns produced the following results: (1) with the tripod mounted gun, 80% to 85% of the men qualified as marksmen or better; (2) with the bipod mounted gun, only 45% to 50% made marksmen or better. Unfortunately, the reliability of these figures cannot be determined since the nature and extent of the research and statistical controls are not known. Accordingly, evaluation of the research is not possible and inferences drawn from the findings are not justified.

Although the M1 rifle has been subjected to considerable study and various scores designated for "marksman," "sharpshooter," and

"expert," the reliability of the obtained scores is open to question. Column 6 of Table 3 lists a number of the most important factors which affect the reliability of the official records. These include the following: (1) the condition of the weapons and ammunition, (2) weather conditions, (3) conditions of test administration, such as reliability of the scorers, timing of the firing, motivational incentives provided, and so forth.

Subject to verification, the appraisal of available records leads to the conclusion that their reliability is low to moderate. For example, the following rifle records, obtained at one of the posts visited, will serve to indicate the suspect nature of the scoring reliability:

Qualification	Company			
	A	B	C	D
Expert	160	0	102	44
Sharpshooter	11	19	55	110
Marksman	0	148	2	4
Not qualified	0	4	2	0
Total fired	171	171	161	158

These and similar records indicate that the scoring and results are not meaningful. Various factors involved in the training (class size, motivational techniques, instructional methods and materials, ammunition allowances, as well as the conditions of testing) all operate to produce soldiers who are not equally proficient (and inter-changeable) with each other.

A previous conclusion bears repetition at this point: job analyses of each of the weapons should be undertaken and proficiency measures developed and validated. Once this is accomplished, the effect on proficiency of the various factors present in training can be systematically and reliably determined. In other words, with reliable proficiency measures it will be possible to study ways by which the training may be made more effective and economical. For example, the relative effectiveness of training devices, instructional procedures, and ammunition allowances can be studied in terms of the end-products achieved.

Some related matters which warrant consideration are:

1. There is evidence that the principles of the tree-type sight are not adequately mastered by most trainees; hence, performance on weapons equipped with such sights is generally poor.

2. The mechanical characteristics of certain weapons (especially the machine guns and mortars) militate against mastery of the

weapon; hence, in spite of an extensive training program, performance on these weapons is generally poor. (Additional comments related to this problem will be found in the last section of this report on human engineering problems.)

3. The difficulty and complexity of certain weapons and related equipment appears to be such that, with present materials and practices of instruction, only selected trainees can be expected to learn the topics of training. For example, in view of the fact that large percentages of trainees are of average or lower intellectual ability, instruction in such an abstract device as the M-10 plotting board is bound to result in considerable failure.

SECTION IV

OFFICIAL TRAINING POLICIES: THE EXAMINATION OF AN ARMY TRAINING PROGRAM

For illustrative purposes, the Army Training Program referred to in this discussion is No. 7-600-1, dated 21 June 1951. This discussion invites attention to certain basic official policies which are worthy of consideration in the evaluation of a training program. Some of the points have already been raised in earlier sections. A complete and detailed examination of official Army training policy would run to too great a length. Therefore, some of the topics have simply been quoted here in independent subsections, with minimum comment.

1. Training Objectives

"The over-all training objective is to produce an aggressive, fighting infantryman with confidence in his weapons and equipment, and his ability to use them, and... which will insure that he:

. . . . . .

b. Develops pride in the Army and desires to carry on its proud traditions.

. . . . . .

q. Is able to fire proficiently any individual infantry weapon (M-1 rifle, automatic rifle, carbine and pistol, etc.) use hand and rifle grenades, and operate the portable flame thrower, and recognizes the superiority of American Infantry Weapons over any other in the world."

r. "Can serve as any member of the crew of a crew-served infantry light weapon (light machine gun, rocket launcher, recoilless rifle and light mortar) in combat, and is familiar with fire direction and fire control for infantry mortars and artillery."

These are not realistic objectives. In view of the findings of this research on proficiency measurement, how can the achievement (or non-achievement) of proficiency be determined? Moreover, in the first statement of the objectives, how is confidence measured? What are the units of measurement? As has already been noted, considerable weapon inaccuracy and malfunction were observed. How does this fact affect confidence? It is entirely possible that the emphasis on punitive discipline during training may militate against the achievement of (b). Finally, it appears that only a select few of the Army population can be expected to achieve all the objectives stated, (q) and (r) especially, in a sixteen-week training period.

2. Methods of Instruction

"The hours of instruction prescribed herein have been reduced to the minimum by eliminating nonessential portions of subjects (principles, procedures, or skills) not directly related to the operational performance of the individual in combat. Times are considered adequate to introduce the instruction and conduct an initial period of practical application. Proficiency comes through subsequent application provided by integrating training or prescribed concurrent training."

Again, if it were clear what criteria were used in making decisions concerning the elimination of "nonessential" material, it would be possible to organize a series of measures of proficiency. Also, the provision only to introduce the instruction and conduct an initial practical application seems inconsistent with the objective stated earlier, namely, to produce a soldier "able to fire proficiently" any infantry weapon.

Furthermore, to depend for proficiency on subsequent application by integrated training or concurrent training is to ignore the facts of training. It was observed of concurrent training, conducted by instructional personnel inadequately qualified to teach, that integrated and concurrent training are either totally absent or are unrelated to the subject of marksmanship instruction. For example, physical training and close-order drill were observed to be training given concurrent with mortar marksmanship. With inadequate numbers of instructors qualified to teach, it is too easy to let integrated and concurrent training become haphazard and inconsistent. Obviously, proficiency, which is supposed to come through these subsidiary training activities, will also be haphazard and inconsistent.

Moreover, attention is invited to the fact that, under present practices, the hours prescribed by the ATP for instruction is greatly different from the amount of time given to each trainee for learning. For example, 81 hours of instruction on the machine gun are prescribed by the ATP. In practice this is taken to mean 81 hours per company. Depending on the size of the company, the number of hours per trainee is only a fraction of the 81 hours allocated to machine gun instruction.

One post, with classes running to 250 or more men, conducted a firing exercise in one eight-hour session. The result was that each trainee actually spent only fifteen minutes out of that eight hours in the activity referred to as the primary subject of instruction. Obviously, the larger the classes become, the shorter becomes the time available per student. Still another problem ignored by the ATP in its time allocations is that movement of men from one area on a post to another area takes time.

The ATP defines concurrent training as follows:

> "Concurrent training is defined as training in a subject, not necessarily related to the subject being taught, that may be given to part of the class while the remainder are being taught the primary subject."

Such a definition is dangerous because it justifies even close-order drill as legitimate concurrent training given to men who have been brought out to a range to learn to fire proficiently the mortar. It is suggested that the "county-fair" type of training described in an earlier section of this report would be a better approach to the problem.

3. Records

> "Units and training companies...will maintain a training attendance record to insure that each individual attains the objectives set forth above. Upon completion of basic training this record may be destroyed, as advancement to a new phase of training or graduation from the training center is evidence that the individual has successfully completed the training required in the program."

It is impossible to avoid the inference that the successful completion of training and achievement of the training objectives is primarily a matter of attendance at the place of instruction. Moreover, it is submitted that graduation is spurious evidence on which to base the assumption that the training has successfully achieved the objectives. However, referring to the previous discussions on proficiency measures, it is not now possible to contest any claims of success.

"Upon completion of training, each individual will be tested by means of a proficiency test to determine whether or not he has satisfactorily mastered the training presented."

Again, reference should be made to the discussion on proficiency measures in the preceding section of this report. It is interesting to note that there are three important omissions in the above statement. First, proficiency has not been defined; second, nothing is said about what records are kept and what use is to be made of the test scores; and third, nothing is said about what is to be done with the individual who has not satisfactorily mastered the training.

The ATP could be further dissected in a similar manner. However, there is no need for additional laboring of the matter. The point which this discussion has attempted to make is that the training policies, objectives, and practices which are prescribed by the ATP are subject to question. The quotations above and their accompanying comments were intended to lead to the recommendation that the Army Training Programs should be examined, evaluated, and restated to provide a clear, definite, and measurable series of objectives to guide the units in training soldiers.

SECTION V

HUMAN ENGINEERING PROBLEMS*

Field observations indicate that marksmanship training is made more difficult and less efficient because of the mechanical design of certain weapons. It appears that, while ordnance and engineering requirements have been carefully considered in the production of most weapons, certain psychological factors have been almost totally ignored.

Examples of psychologically poor mechanical design are found in the deflection control knobs of the 60-mm M-2 mortar, the 81-mm

*For definitive discussions of this topic, reference should be made to publications such as: Handbook of Human Engineering Data (2nd edition), Institute for Applied Experimental Psychology, Tufts College, Technical Report SDC 199-1-2; P. M. Fitts. "Engineering Psychology and Equipment Design." In S. S. Stevens (Ed.) Handbook of Experimental Psychology. New York: John Wiley & Sons, Inc., 1951. Pp. 1287-1340.

M-1 mortar, the 4.2-inch M-2 and M-30 mortars, and the tripod-mounted light and heavy machine guns. In each of these weapons the deflection control is manipulated by a forward-backward movement, the knob being in the vertical plane parallel to the plane of the barrel. These movements do not move the barrel in the expected direction, namely, up and down. On the contrary, the barrel moves right or left in the horizontal plane. Most individuals have well-established stereotyped responses and expectancies when confronted by control knobs. The responses and expectancies are the result of many experiences in everyday life, such as driving cars, bicycles, and so on, where a movement to the right calls for a turn of the control wheel to the right; a turn to the left results in a movement to the left.

The present design of many control knobs not only fails to utilize established responses which the recruit brings to the training, but also necessitates extensive training to develop proficiency in the manipulation of controls. It is interesting to note that even experienced mortarmen were observed to take a half-turn on a knob to determine the direction of the resulting barrel movement.

Another training problem is introduced by a lack of standardization of common controls from one to another of functionally related weapons. For example, in the above-mentioned mortars a given movement of the deflection control on one of the mortars results in a barrel deflection in a direction opposite to that obtained on another mortar. Likewise, on the tripod-mounted machine guns, a given "push" and "pull" of the deflection control produces a movement on the light gun which is different from that on the heavy machine gun.

This lack of standardization of control knobs and wheels has a three-fold effect: (1) a loss of time and accuracy of performance as a result of response interferences, (2) an increase in forgetting of learned responses in conflict with each other, and (3) a need to provide special training for each of the weapons since minimum "transfer" from one weapon to another occurs.

In connection with this problem, it was also noted that there is no standardization of the adjustment elements of the rear sights of a number of weapons. Specifically, one click of windage corrects the strike of the bullet from the M1 rifle one inch at 100 yards; on the other hand, one click of adjustment on the automatic rifle (M1918A2) moves the strike of the bullet four inches at 100 yards. Furthermore, training efficiency is adversely affected by the design of sight scales on many weapons. For example, the sights on the automatic rifle (M1918A2), the light machine gun (1919A4), and the heavy machine gun (M1917A1) were difficult to read accurately and rapidly. The scale of the M-4 sight on the 60-mm M-2 mortar also illustrates poor design for efficient use because algebraic additions and subtractions are required while making

TABLE 4

SOME HUMAN ENGINEERING PROBLEMS

WEAPON	PROBLEM	RECOMMENDATIONS
Machine Guns	a. Non-conformity to populational stereotypes of required responses for manipulating the gun in elevation and deflection. b. Non-standardized controls on the tripod mounted light and heavy machine guns. c. Scale increments on the disk scale of the heavy machine gun and the clinometer not standardized.	1. Determination of populational response stereotypes involved in the manipulation of control knobs, dials, and hand wheels. 2. Determination of the most efficient types of scale markings, scale increments, and information displays to be used on infantry weapons. 3. The psychological characteristics of sights and controls should be standardized for groups of functionally related weapons. 4. Personnel trained in psychology and human engineering should be included on weapon development and research boards.
Mortars	a. Non-conformity to populational stereotypes of required responses for manipulating sight and gun in elevation and deflection. b. Non-standardized elevation scales on the 60-mm, 81-mm, and 4.2-inch mortars. c. Non-standardized controls among the three infantry mortars. d. M-4 sight deflection scale source of manipulation errors.	
M1 Rifle	a. More frequently used elevation knob less accessible than is the windage knob. b. Non-standardization of windage adjustments between the M1 and the automatic rifles.	
Recoilless Rifle - 57 mm	a. Use of triangular peep sight not standardized with circular peep sight used in majority of other infantry weapons.	

adjustment. The result of such scale inadequacies is a large number of scale-related performance errors made by both recruits in training and experienced personnel in operational situations.

Another noteworthy example is the location of the windage and elevation adjustment knobs on the rear sight of the M1 rifle. The more frequently used elevation knob is less readily accessible (on the left of the sight) than is the windage control knob (which is on the right of the sight). This tends to delay a marksman when making adjustments during rapid fire. Accordingly, the reversal of the positions of the two control knobs on the M1 rifle should be considered.

It is apparent that these mechanical characteristics cannot be corrected immediately. Nevertheless, it is strongly recommended that certain psychological and educational specifications be considered along with ordnance and engineering requirements in the development of new weapons. Moreover, experimentation and further research on extant weapons may add further insight into the problems of a machine in the hands of a human operator.

Table 4 presents a summary of human engineering problems.

SECTION VI

RECOMMENDATIONS

The recommendations for needed work have been listed in the various tables. These recommendations have been grouped together in this section in order to furnish a summarized listing.

The recommendations have been divided into three sections: (a) recommendations for training aids development, (b) recommendations for training procedures, and (c) recommendations which will take advantage of established educational practices and which do not require experimental research.

Training Aids

1. Devices to give immediate knowledge of results for all direct fire weapons in dry and wet firing practice

2. Automatic and reliable scoring devices for firing direct fire weapons

3. Individual size trigger squeeze device which gives kinesthetic and visual knowledge of results (M1 rifle)

4. Working model of M1 rifle rear sight (group size) for instruction on sight changes

5. Instruments to measure an individual's sight picture and sighting behavior on direct fire weapons

6. Device (three dimensional) to teach principles of sight correction on the M1 rifle

7. Individual size device to teach trigger "press" on the automatic rifle

8. Training shell ammunition with contact-exploding smoke charges for the rifle grenade launcher, 60-mm, and 81-mm mortars (needed to give knowledge of results in training-shell range firing)

9. Tracking trainer which permits simultaneous deflection and elevation tracking for use with all direct fire weapons when used in tracking targets

10. Three-dimensional device to teach principles of bore sighting on the rocket launchers and the recoilless rifles

11. Device to teach principles of the tree-type sight on the rocket launchers and the recoilless rifles

12. Subcaliber device for the recoilless rifles which provides back-blast and noise

13. Modified versions of existing sight picture devices for the rocket launchers and recoilless rifles which show distance perspective when targets vary in range

14. Modified Cook Mortar Demonstrator to illustrate (three-dimensional) relationships of shell trajectory, sight change, and barrel position

15. Group size working models of all mortar sights

16. Device composed of binocular reticle, target, and burst indicator (group and individual size) for training in Forward Observation Procedure

17. Subcaliber shells, capable of reaching realistic ranges, for use with the 4.2-inch mortar firing device

18. Production and validation of training films on certain selected phases of marksmanship training for all infantry weapons with special emphasis placed on participation type films of technical topics

Training Procedures: Research and Development Recommendations

1. Job analysis of marksmanship performance on all weapons in the present survey

2. Development of reliable proficiency measures for all phases of marksmanship performance on all weapons

3. Determination of optimum instructor-trainee ratio for effective training on the weapons

4. Determination of optimum length of "blocks" of instruction and most advantageous distribution of practice for the various marksmanship subjects

5. Development of inclement weather schedules and research to determine the effect of such schedules on qualification scores on all weapons

6. Research on the effect of emphasis on body firing positions on proficiency in the operational situation

7. Determination of effect of using clearly defined targets in known distance and 1000-inch firing on attitudes and performance in firing at poorly defined (operational) type of targets

8. Research to determine whether the carbine can be taught before the M1 rifle as a less complicated weapon and whether a resultant increase in learning and proficiency on the M1 rifle can be achieved

9. Determine the effect of small bore firing on .45 caliber pistol learning and performance

10. Determination of effect of delayed target critique on machine gun firing performance

11. Determination of whether use of landscape targets (paper) facilitates mastery of "search and traverse" task on the machine gun

12. Determination of effective methods of teaching skills which must be executed in a given order, such as the fire commands in mortar firing

13. Redesign and simplification of the M-10 Plotting Board

14. Development of a simplified and effective procedure to teach the use of the M-10 Plotting Board

15. Research on personnel selection for mortar instruction

16. Development of a course of instruction to teach range estimation effectively and research to determine its most effective integration in present instruction

17. Experimental determination of the effect on .30 caliber marksmanship of .22 caliber firing interspersed in M1 rifle instruction

18. Experimental determination of the relative advantage of the "coach and pupil" method of training over other procedures which permit varying amounts of active practice and communication between trainees

19. Research to determine the effect of reduction of time devoted to preliminary rifle instruction compared with the present time allocation

Training Procedures: Implementation of Learning Principles Not Requiring Research

1. Examine present program of instruction and training procedures for the inclusion of positive motivational incentives

2. Examine present program of instruction and training procedures to determine the relevancy of concurrent training topics

3. Reschedule phases of machine gun instruction to eliminate any overlapping of (conflicting) instruction between the tripod mounted light and heavy machine guns in order to minimize interferences which may induce conflicting responses in manipulating the two guns

4. Develop mortar firing ranges which permit adequate knowledge of results for each of several simultaneously fired weapons

5. Re-evaluate the need for personnel selection for mortar instruction

6. Re-evaluate present training manuals to determine whether they are too technical (and too all-inclusive) for the average recruit, and if so, develop new and simplified manuals

7. Examine present training program to eliminate unnecessary instruction and provide "free" hours for make-up instruction

8. Re-examination and evaluation of supervision and inspection procedures

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